EUGÈNE MARAIS

THE SOUL OF THE APE

THE SOUL OF THE WHITE ANT

Two classics of natural history together in one volume

PENGUIN BOOKS

THE SOUL OF THE APE

THE SOUL OF THE WHITE ANT

Eugène Marais was born in a farming community near Pretoria in 1872. Journalism was his first career, but he later studied law in London, and by 1910 was in Johannesburg trying to establish himself as an advocate. Increasing depression drove him to retreat to Waterberg, a mountain fastness in the northern Transvaal. Settling near a large group of chacma baboons, he became the first man to conduct a prolonged study of primates in the wild. It was this period that produced *My Friends the Baboons* and provided the major inspiration for *The Soul of the Ape*. He returned to Pretoria to practise law, to resume his career as a journalist, to continue his animal studies and to write poetry in Afrikaans. In 1926, the year after he had published a definitive article on his original research and conclusions about the white ant, a world-famous European author took half Marais's life-work and published it as his own. This plagiarizing may well have been a major factor in Marais's final collapse. Plagued for many years by ill-health and an addiction to morphine, he took his own life in March 1936.

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INTRODUCTION

BY ROBERT ARDREY

HE was a man courtly, gentlemanly in every oldtime ecstatic sense, yet also handsome according to more lasting definitions of masculine beauty. (We should say today that he possessed charisma.) His charm was something that contemporaries who outlived him recall with yearning. His paternal magnetism was that of a Pied Piper of Hamelin, a quality to which we shall return for detailed inspection. But he was a poet with no eternal page to write upon. As a scientist he was unique, supreme in his time, yet a worker in a science then unborn. He was a freak, spawned by the exuberance of mankind, an immortal who speaks from his grave: Beware and do likewise. That he died by his own hand may seem an afterthought.

Eugène Marais was a human community in the person of one man. He was a poet, an advocate, a journalist, a storyteller, a drug-addict, a psychologist, a natural scientist. He embraced the pains of the many, the visions of the few, and perhaps the burden was too much for one man, But perhaps, also, none but such a human community could have written, almost half a century ago, *The Soul of the Ape*. This lost manuscript, recently discovered, must rank today as a significant contribution to a science that did not exist at the time of its composition.

When in 1961 I dedicated *African Genesis* to Marais's memory, I wrote: 'As no gallery of modern art can fail to be haunted by the burning eyes of Vincent Van Gogh, so the pages of no future science can fail to be haunted by the brooding, solitary, less definable presence of Eugène Marais.' At that time we knew of the existence of the manuscript

through his letters. And we knew its theme: the evolutionary origins of the subconscious mind in man. But after his death in 1936 the manuscript could not be found. And a quarter of a century later it seemed lost forever. Now, with the recovery and publication of *The Soul of the Ape*, Marais's presence in the sciences takes on arresting definition. But it remains no less solitary, no less brooding; no less, like some lost and recovered portrait itself, a tragic masterpiece.

Eugène Marais was born in South Africa in a farming community near Pretoria in 1871. In a letter he described it as 'an isolated *uithoek*, as completely cut off from the rest of the civilized world, as the loneliest isle in the Pacific'. His family was Afrikaner, of the same people who in the 1830s had abandoned the Cape of Good Hope to the new domination of the English and had driven their ox-teams, their covered wagons, their herds far north into the African interior to found their own republics, the Transvaal and the Orange Free State. These people, in turn, were descendants of the original settlers sent out to the Cape by the Dutch East India Company in the later 1600s. Although we tend to think of the Afrikaner as entirely Dutch-derived, in fact there were many French among them. Huguenots, they had taken refuge in Holland; and the Dutch government, not knowing quite what to do with them, sent off many along with their own colonists to that shining end of the world, the Cape of Good Hope.

Marais is a common name in South Africa. I have heard the joke passed that had there not been among those early settlers two Frenchmen named Marais, both of enormously prolific potential, South African telephone directories would be many pages shorter. French though the name may have been to begin with, today it is as typically Afrikaner as Van der Merwe. Within a very few generations after the founding of the colony in 1652, Dutch and French had merged their peoples into the identity we know as the Afrikaner, speaking

the language we call Afrikaans. The history of his people and their language, we shall see, entered like some old fated burden into the life of Eugène Marais.

There are contradictory versions of Marais's early life, even of his place of birth. His son, for example, believes his father to have been born in Pretoria, but I am drawing my version largely from Marais's own account (however unreliable) as described in letters to his translator in London, Dr Winifred de Kok, all written shortly before his death. The letters have never been published, but each is a testament to his wit, his compassion, and his perception – not to mention his mastery of the English language. In one he writes, 'My first schoolmaster – in fact the only one procurable during my boyhood days – was a missionary of the Church of England, who is still alive and has risen to high honours in the hierarchy of his communion. He has never learned to speak a word of Afrikaans.'

From the years of his earliest education Marais was acquiring his admiration on the one hand, and his resentment on the other, of all things English. He seems to have spent some of his early years in Pretoria, some in the Orange Free State, and he finished his schooling in Paarl, the lovely vineyard-fenced town in the Cape. When he settled in Pretoria, the capital of the Transvaal Republic, he began the first of his careers, as a journalist. Such was his energy that by 1890 he was editor of *Land en Volk*, and by 1892 when he was twenty-one, he owned it. His son reports that his father's comments as a parliamentary reporter were so caustic that he received the first of many honours, exclusion from the press gallery by resolution of the entire *Volksraad*. Later, as a consequence of his resolute attacks on the mighty Paul Kruger, president of the Transvaal, he received a still higher honour, indictment for high treason. He was acquitted by the Pretoria Supreme Court.

It was during this period of journalism that he was intro-

duced to morphine. He suffered severely from neuralgia, and the drug was easily available. In 1894, when he was only twenty-two, he married, only to see his young wife die the following year after the birth of their son. How much the blow contributed to his later, lifelong addiction we cannot know. But quite shortly he gave up his career in Pretoria and went to London, where on the advice of friends he studied law. He refers in his letters to medical studies as well, and his understanding of physiology would seem to confirm it. But by the time of his admission to the bar at London's Inner Temple, there had come the Boer War.

No episode in modern history so acted to give imperialism a bad name as Britain's war against the Boers. So long as the little republics of the Transvaal and the Orange Free State consisted of nothing but a few communities of outland farmers with a peculiar language and peculiarly independent ways, there was little to tempt the acquisitiveness of great powers. But when in 1886 gold was discovered on the reef where Johannesburg now stands, and there began a rush for the Witwatersrand to which not even the Klondike can be compared, then it could have been predicted with certainty that the peaceful years had ended. Britain launched its war of conquest in 1899, and in London Marais became an enemy alien on parole.

With ease we forget our own past obscenities: with difficulty we forget the obscenities of others. We tend today to dismiss the Boer War as a tiresome episode in somebody else's history. But it was a war obscene in both purpose and execution. Unable to inflict final defeat on the Afrikaner commandos with their guerrilla tactics, Lord Kitchener turned to a scorched-earth policy and introduced to the language of the twentieth century the concentration camp. The high veld, was devastated, crops and farmhouses burned, livestock driven off, Boer families pressed into camps. It is true that over a hundred thousand survived the con-

centration camps. But it is also true that by the war's end twice as many Boer wives, children, elderly had died of Kitchener's new invention as Boer men had died before Kitchener's guns. The Afrikaner would never forget.

Eugène Marais never forgot. The private tragedy which morphine would bring to his life was now compounded by the public tragedy of his people. While according to his letters his intention had been to qualify in medicine as well as law, by the end of the war in 1902 he had escaped from Britain and was in Central Africa with an expedition trying to get munitions and medical supplies to his countrymen across the Limpopo. He was too late. Decades later, in September 1935, writing to his translator in London, he recalled the circumstances of his education in English, of his long experience in London, and of the final defeat. And he wrote:

> You will perhaps be astonished to learn what my psychological 'reactions' were to the jumble of circumstances. The most enduring result was that it made me far more bitter than men who took part in the war at a more advanced age and who had had less to do with the English before the war. It was for purely sentimental reasons that I refused to write in any language but Afrikaans, notwithstanding the fact that I am far more fluent and more at ease in English. I have written several monographs in other languages; but they were all scientific and most of them were at once consigned to the oblivion of archives of learned societies. The nearest I ever attained to 'publication' in this connection was a monograph of mine included in the annals of the Smithsonian Institution, a thing which I believe is regarded as a desirable honour by scientists throughout the world.

Ours is the good fortune that he wrote his lost, unfinished masterpiece, *The Soul of the Ape*, in his own easy English. Eugène Marais, Jr, believes that his father intended it for the Smithsonian Institution in Washington. But it was Marais's tragic fortune that the pain of his people became so intensely his own that he confined almost all of his writing to a

language understandable by so few. Not until after his death were translations of his two minor classics, *My Friends the Baboons* and *The Soul of the White Ant*, published in English.

There is a degree of disagreement as to the exact date when Marais initiated his studies of animals in a state of nature. In *African Genesis* I wrote that 'so deep was his depression immediately following the war that, renouncing the society of men, he retreated to the Waterberg, a mountain fastness in the northern Transvaal, and accepted the society of animals ... The date, one must calculate, was 1903.' The internal evidence of *The Soul of the Ape* roughly supports the calculation. As Marais describes the situation, his intimacy with the baboons of the Waterberg was only possible because for years the area had been depopulated, the animals had heard no gun fired, and it would still be a time before the ruined farmers and their families would return to resume their lives. We now know, however, that in Central Africa Marais contracted malaria, an affliction which would recur throughout his life. In 1903 he was hospitalized in Portuguese East Africa, and not till the following year did he return to Pretoria.

We may never know the exact date when Marais retreated to the Waterberg. We can be sure only that it was at an early moment in the century, and that when he and a companion took up residence near a large, wild troop of chacma baboons he became the first man in the history of science to conduct a prolonged study of one of man's primate relatives in a state of nature. But we must not overstress his then role as a scientist. He was a novice. No boy could have grown up as did he, of course, in the South African back country and failed to gain fascination for animal ways. Whatever medical training he may have had in London to forward his sophistication in the natural sciences, his legal training sharpened his sense of observation and proof. But Marais was untrained and, in the

field of animal observation, unsophisticated. In *The Soul of the Ape* he emphasizes the handicaps of isolation – lack of libraries, means of finding out what others had accomplished. But wisely he adds: 'We approached this investigation without any preconceived ideas, and although at the beginning inexperience may have left much to be desired in our methods, we had at least no theories to verify.'

Since Marais was scaling a scientific Matterhorn that no man had ever attempted before, it was well for him – and for us – that he carried no obsolete luggage. The early vignettes of his life in the Waterberg are the substance of the volume *My Friends the Baboons*. They are among the most charming tales ever told by a naturalist. It would be almost sixty years before a comparable study of the wild baboon would be made by trained observers, and the wonder is not that this untrained pioneer should have made errors of observation and interpretation, but that his sight in general should have been so true. Nevertheless, the reader seeking the facts rather than the joys of life should proceed with care. In his letters Marais wrote: 'As a matter of fact, I have always been a little ashamed of these tales, they lie so far outside the sphere of what I have always regarded as my real work. They appeared as feuilletons in an Afrikaans newspaper and were never intended to assume a more enduring apparition.'

The scientist who in his maturity would write *The Soul of the Ape* may well have been embarrassed by the early tales. But *My Friends the Baboons* has endured, despite its author's qualms, as a slim, unforgettable volume, the first of its kind in our literature. And the three years in the Waterberg not only relieved Marais for at least a time from the pain of a world from which he had fled, but immersed him in animal wonders that, taking shape in his mind, would provide the frontier for a new science.

Later in this essay I shall come back to the years in the Waterberg, since they furnish a main stage as well as major

inspiration for *The Soul of the Ape*. His work there no longer possible, he returned to Pretoria to establish himself as an advocate and resume to an extent his career as a journalist. Through the years, however, he seems never to have ceased his serious progress as a scientist or to have lost contact with bush and veld. His main preoccupation took form: the human psyche. With that preoccupation his life work took two roads, the study of those animals most like ourselves, the primates, and the study of those most unlike ourselves, the social insects. And as if all this were not enough, he began to find in his native language the materials of the poet.

Throughout its history the Afrikaans language had been largely of a vernacular sort. Then perhaps as another psychological consequence of the Boer War, a surge of literary activity came about. Granted Marais's morbid dedication to Afrikaans, his fascination for the movement may be easily understood. As early as 1885, when he was fourteen, he had written his first poem in English. But *Winternag* was one of the earliest of his Afrikaans poems to find high place in the new literature. In it, and in all his poetry, one finds a brooding, a melancholy, an expression of man's fate. One of the most memorable is *Mabalêl*, a haunting fable of the chieftain's lovely daughter who in all gay innocence ran down to the bank of the Limpopo for water:

Vinnig langs die paadjie trippel Mabalêl;
Vrolik klink die liedjie
Wat die klingelinge van haar enkelringe vergesel.

Swiftly down the footpath comes tripping Mabalel
And gaily sounds the song she sings
To the rhythm of her tinkling ankle-rings.

Nothing could warn her that in the depths waited the crocodile, Lalele. No word, no thought, no hint could penetrate the innocence to speak of a monster ever-waiting.

Marais's lifelong burden of pain, of compassion, of perception all combine in the single poem. And somehow, too, the poem speaks of that devouring secret side – despite all gaiety, despite all charm – like Lalele, lying always waiting in the depths of Marais's own nature.

A good many years ago Professor J. S. Weiner, Oxford's celebrated anatomist, told me a story about Marais that better than any other I have ever heard probed the hidden darkness. Weiner is a South African who grew up in a district of Pretoria called Sunnyside and many years later achieved world fame when with Kenneth P. Oakley of the British Museum he proved that the Piltdown skull, then presumed to be the remains of man's earliest ancestor, was a hoax. I had never met Weiner when, in Rome for a conference, he came to our apartment to spend an evening. And he startled me, for he had no more than found a chair before he asked why I had dedicated *African Genesis* to Marais.

There was little to explain. I said that I felt science had neglected Marais, and that, while I was not a scientist, it had seemed the least I could do. 'I'm glad you did it,' said Weiner, 'I know I've always felt guilty about him.' And he told his story.

When Weiner was a boy in Sunnyside one of the most thrilling of events was the sight of Eugène Marais – dignified, dressed always in immaculate white – walking down towards the river in the evening. It was a signal to all the children along the street. They came piling out of yards and gardens and upstairs rooms to follow Marais to the river. There he'd find an old stump or a log to sit on, while they arranged themselves on the ground. And he would tell stories. All acquaintances recall him as one of the most consummate storytellers of his time and place, but the mightiest of witnesses were the children at his feet, listening with long-held breath to his stories of bush and veld and dusty roads where mambas slink. The dark would come on. He would rise and go home,

and the children, full of magic, would return to new worlds.

Marais had a room in a house just a few doors down the street. Weiner's sister, friendly with several girls who lived in the house, had come to know him, and one day asked Weiner to return a book to Marais's room. Clutching the book, consumed by the excited possibility of meeting the magic-maker alone, he went to the house, found the room, knocked. There was no answer. He tried the door. It was unlocked. He entered cautiously. The room was dank with disorder. And there was a strange smell. He put down the book and fled.

Many years later – in 1940, years after Marais was dead – Weiner was a medical student at St George's Hospital in London. In a pharmacological course the students were learning to identify a variety of pharmaceutical items. He was handed a sample of some drug with a very queer smell. Instantly he had a vivid recollection – a total recall – of a room somewhere. He struggled to identify the room, and knew it must be somewhere in South Africa. Then it came to him – Marais's little room. The drug was morphine.

Throughout Marais's life there were the long periods of intense study and outpourings of work when he was in command of his life at whatever inner cost. In such periods he continued his observations of the termite and organized his revolutionary conclusions concerning the insect's social life. In such periods he continued his observations of the baboon both in the wild and in captivity, planned and executed his experiments with the human subconscious and its hypersensitivity under hypnosis, and wrote but did not quite finish *The Soul of the Ape*. And then there were the periods of breakdown, when friends spoke delicately of his 'bad health'. But always he regained command of himself and returned to his work. And so it is fair to surmise, I believe, that the plagiarizing of his work by a world-famous European author was a major factor in his last collapse.

So far in this essay I have emphasized his work with baboons. Of equal importance, and at the farthest point removed on the animal spectrum, was his study of the termite, in his day called 'the white ant'. His scientific scheme was clearly disciplined: to investigate on the one hand the evolution of mind in that family of animals leading to man; and to study on the other the evolution of instinct in that branch leading to the most complex of insect societies. And he came to a stunning conclusion.

Termitaries, as one sees them so frequently in Central and Southern Africa, are tall, compacted columns of earth sometimes twelve or fifteen feet high. Within lives the society, with its castes and its ranks, in countless number. And Marais concluded that all members of the colony and the termitary itself form what is essentially a single organism. The termitary itself is the body. The various castes in the society have the functions of the body's organs, with fungus gardens contributing the digestive tract, soldiers and workers the cells of the blood stream, the queen the brain as well as the reproductive organs, and even the sexual flight executing the function of sperm and ova. How all communicate we do not know, but the 'soul' of the white ant – the psyche, we should say – is the property of the entire society.

Marais's conclusion was new and quite radical. Intending to gather all of his studies into a book one day, he began in 1923 to publish a series of articles in Afrikaans newspapers and the widely circulated magazine *Die Huisgenoot*. While Afrikaans is all but a secret language to the world at large, Dutch and Flemings read it without difficulty. And Maurice Maeterlinck was a Fleming.

A definitive article was published by *Die Huisgenoot* in 1925. Maurice Maeterlinck, dramatist and poet, was then a reigning figure in continental literature. Early in his career he had published *The Life of the Bee*, a mixture of philosophy and natural history, but he was not a scientist. Maeterlinck's

reputation rested solidly on a long line of poetic dramas, and in 1911, shortly after the production of *The Bluebird*, he was awarded the Nobel Prize for literature. How a man of such stature could in later years commit such a crime, I do not know. But in 1926, the year after the appearance of Marais's article, Maurice Maeterlinck published in French a book that by the following year appeared in English and in several other languages. In that book, without acknowledgement, Maeterlinck took half of Marais's life work and published it as his own. *The Life of the White Ant* stands even today on many a library shelf, but the name on its cover is that of a plagiarist.

In South Africa there was a furore. When Dr de Kok in London, in 1935, was beginning her translation of Marais's *The Soul of the White Ant*, he wrote her, recalling the episode:

> You must understand that it was a theory which was not only new to science but which no man born of woman could have arrived at without a knowledge of all the facts on which it was based; and these Maeterlinck quite obviously did not possess. He even committed the *faux pas* of taking certain Latin scientific words invented by me to be current and generally accepted Latin terms.
>
> The publishers in South Africa started crying to high heaven and endeavoured to induce me to take legal action in Europe, a step for which I possessed neither the means nor inclination. The press in South Africa, however, quite valorously waved the cudgels in my behalf. The Johannesburg *Star* (the biggest English-speaking daily in South Africa) published plagiarized portions which left nothing to the imagination of readers. The Afrikaans publishers of the original articles communicated the facts to one of our ambassadorial representatives in Europe and suggested that Maeterlinck be approached. Whether or not this was done, I never ascertained. In any case, Maeterlinck, like other great ones on Olympus, maintained a mighty and dignified silence.

That a Nobel Prize winner and a literary figure of such

renown could have stolen half the life-goods of an obscure South African genius must leave one not only with shame but bewilderment. How could he have done it? Yet Maeterlinck's guilt is clear. With the admirable cooperation of the Johannesburg newspaper to which Marais referred, I have obtained from the 1927 file copies of the original report. An excerpt is reproduced in this book.

Marais's was a star-struck, star-crossed life; and with the Maeterlinck episode the stars, I suggest, crossed once too often. The Crocodile, Lalele, lay always waiting within the dark pools of his being. Despite his objective, even humorous, recollections of the crisis in letters of later years, I do not believe that he ever regained the scientific urgency that had commanded his earlier investigations. He wrote not a few popular summations of his work. He published several excerpts from *The Soul of the Ape* rewritten in Afrikaans. But I find no record of scientific accomplishment after 1927. And we may recall that it was 1929 when young Weiner encountered the strange odour in Marais's room.

Morphine and misfortune beyond mortal endurance combined slowly, ever so slowly, to put out the light. It flared once more, however, undimmed and undaunted, in a letter to Dr de Kok written on 20 October 1935. Earlier he had written that after she finished the translation of his termite articles, they might consider what was to be done about his unfinished and unpublished *Soul of the Ape*. But he confessed, 'I write this in bed under the spur and inspiration of enduring pain,' and spoke of his inability to find energy or enthusiasm for the work. Now, however, he wrote:

> You see that your kindly enthusiasm has infected me! . . . The thought of reaching a bigger public intrigues me. You must know that a great deal of the work I did and my interpretations of the results will be new to science. No other worker in the field ever had the opportunities I had of studying primates under perfectly natural conditions. In other countries you are lucky if you catch

a glimpse of the same troop twice in a day. I lived among a troop of wild baboons for three years; I followed them on their daily excursions; slept among them; fed them night and morning on mealies; learned to know each one individually; taught them to trust and to love me – and also to hate me so vehemently that my life was several times in danger. So uncertain was their affection that I had always to go armed, – with a Mauser automatic under the left armpit like the American gangster!

But I learned the innermost secrets of their lives. You will be surprised to learn of the dim and remote regions of the mind into which it led me. I think I discovered the real place in nature of the hypnotic condition in the lower animals and men. I have an entirely new explanation of the so-called subconscious mind and the reason for its survival in man. I think that I can prove that Freud's entire conception is based on a fabric of fallacy. No man can ever attain to anywhere near a true conception of the subconscious in man who does not know the primates under natural conditions.

Please don't worry about the health business. It was silly of me to write in the strain – just a period of avernal gloom to which I am occasionally subject. Accept my thanks and salutations.

Sincerely yours,

Eugène N. *Marais.*

On the following 29 March he killed himself.

Back in 1895, when Eugène Marais's wife lay dying, Sigmund Freud, working in Vienna, made one of the supreme discoveries of modern science. Using hypnosis as a tool, he discovered in patients suffering from hysteria the influence of unconscious forces on our psychic processes. The existence of these forces has never since been seriously disputed. Beneath all our actions, our decisions and dreams, our regrets, our hopes, our little lies that we tell each other and our big lies that we tell ourselves, works an engine of which we are unconscious, reinforcing or distorting our conscious, seemingly rational minds.

Introduction

The human psyche has frequently been compared to an iceberg. And in the early days of the polar flight from Copenhagen to California, when planes were smaller and still flew low enough and slow enough for the passenger to see something, there was a wonderful sight along the way. Crossing the Denmark Strait between Iceland and Greenland, you looked down on icebergs floating south. Each was a white jewel glittering in the low northern sun, and were you a passenger viewing the icy mountain from a ship's deck, this would be all that you would see. But from one's window in heaven you saw far more. Painted turquoise by the waters, the immense underwater mass of the iceberg spread all about beneath your eyes. Majestic the frosty mountain of ice might be; but hidden in mighty mystery was the force that supported it. And such is the unconscious mind.

While I believe it true that the reality and the significance of Freud's discovery have never encountered other than superficial dispute, the same cannot be said of its nature. We have argued to this day as to just what the unconscious consists of. And if we are to set our compass as we approach Marais's venture into the unknown, then we must acquire a little perspective: we must see it as a portion of one of our century's most profound scientific controversies.

To begin with, we should understand that *The Soul of the Ape* is a poet's title for a scientific work. It is symbolic. I suggested earlier that where Marais used the word 'soul', we should more prosaically say 'psyche'. But beyond that, his reference to the ape may prove for some disconcerting. The principal object of his study was the baboon, not an ape at all but an overgrown and extraordinarily intelligent monkey. The difference is immaterial. What Marais was observing was the evolution of mental processes in higher primates, and what he concluded from the baboon could only carry greater force in the more highly developed chimpanzee or gorilla.

A second point of early reassurance should be demanded,

that concerning the authenticity of the document. We have, of course, the original manuscript in Marais's handwriting, and for anyone familiar with his work and thought the question would probably not arise. Nonetheless, it must be admitted that we know very little, at least at present, about the manuscript's history. Letters to his son suggest that it was written in 1922, and friends of the period recall that at that time he talked of little else. But what happened to it? We know that in 1935, writing his translator, he referred first to his inability to finish the work, and then to his excitement concerning it. When some months later Dr de Kok received the news of his death, she immediately wrote his son inquiring about the manuscript. On 22 May 1936 Eugène Marais, Jr, replied: 'I also received your letter asking me for the field books and notes of my father. I am sorry there are none. All that I got was about a third of a sack of papers – old letters, accounts, and your contract. There is no sign of a manuscript and no notes . . .'

Dr de Kok was unaware of the existence of the manuscript until I wrote her in the spring of 1968, after receiving a copy myself from the Cape Town publishers. They in turn had been unaware of its existence a few months earlier, when they had invited me to write an introduction to a volume of Marais's minor pieces. In the meantime, the manuscript was submitted to them by the son. Where had it been in the meantime, through all the years? Truly lost? Or hidden? And by whom? And why? The mystery must remain for perhaps a very long time a vexing question. But the reader has the right to ask, is it then authentic? Is it possible that a document almost half a century old can today make a dynamic and original contribution to the evolutionary approach to human understanding, a scientific trend that has thrived only for the past few years?

By good fortune, we need not speculate. Solid evidence exists concerning the author and the approximate date of his

work. In 1926, just before the ruin of the Maeterlinck episode, Marais published in English a paper called *Baboons, Hypnosis, and Insanity*, in a journal called *Psyche*, almost as obscure as himself. Several years ago my younger son excavated it in the library of Harvard University, and I have in my possession a photocopy. In that article Marais briefly summed up what one now recognizes as the material and general conclusions of *The Soul of the Ape*. He wrote: 'Inevitably the conviction gathers force that the so-called "subliminal soul" – the subconscious mentality – is none other than the old animal mentality which has been put out of action by the new mentality.' It was the essence of his discovery. Had the book been published in its own day, so scanty was our then understanding of evolution, it would have been ignored. Today it will still be disputed by the more retarded minds within our academic community. Just as there is little question about the manuscript's authenticity, there is also little question but that our sciences of human understanding are only now beginning to catch up with Marais.

And so a larger question than authenticity must loom before us: How can it be that this lonely man, pursuing his lonely work amid tortured thoughts, could have been quite so far ahead of his time? Or to turn the question around: How can it be that in the first seven decades of the century after Charles Darwin's, world science – the core of modern civilization – is only now getting around to certain probable facts of life so apparent to Eugène Marais? It is a story as remarkable as that of Marais himself, and, so far as the welfare of man is concerned, even more tragic. Let us return to Freud.

The discovery of the role of the unconscious in the human psyche took place, as I have said, near the turn of the century. Sigmund Freud then pioneered the technique of psychoanalysis as a more practical substitute for hypnosis in

exploring the hidden psychic channels of a disturbed patient, and bringing out into the area of consciousness the guilts and repressed memories which had contributed to the disturbance. But the Viennese master became enamoured with the sexual impulse as the central force in the human unconscious. His preoccupation with sexuality brought him into furious encounter with the prim intellectual leftovers of the Victorian age. It brought him also into conflict with his two most eminent colleagues and disciples.

Alfred Adler, unable to stomach the sexual monopoly, saw in the drive for power and dominance a more profound ingredient in the unconscious forces of our behaviour. (Present research into animal behaviour may confirm Adler's position and bring about a resurgence of his reputation.) Carl Jung turned from the overheated corridors of sex to the cooler rooms of myth and religion for fresh explanations. But Freud continued to dominate the main stage of psychic investigation. To him, the sexual drives and frustrations of parents and children seemed the formative struggle for the adult unconscious mind. He gave us the Oedipus complex as a universal attribute of man, inherited from primal days when within the confines of the family the sexual desire of the son for his mother encounters the implacable hostility of the father.

Freud's errors were many, and in his time perhaps unavoidable. He saw man's primal social unit as the family, as it unquestionably was not. He saw the sexual drive as dominating the actions of all higher animals, which just as unquestionably it does not. He lived and worked in a special corner of the bourgeois western world at a time when sexual repression was at its most severe; and from this passing, parochial base he extended timeless generalizations to all mankind. And besides all this, he worked exclusively with the sick, drawing from them improbable conclusions concerning the well.

We may be grateful to Freud that he presented us with the

concept of the unconscious mind. And we may be grateful also that it was largely his sensational preoccupation that in the end would crush the sexual taboos of his time. Yet we may note in passing that today, when sexual repression is vanishing at such a startling pace, we see no comparable vanishment of mental illness.

This was the 'fabric of fallacy' to which Marais referred in the letter to his translator. He did not live to witness the spread of a new fabric of fallacy which would challenge the old.

Sigmund Freud published *Beyond the Pleasure Principle* in 1920, two years before Marais wrote *The Soul of the Ape*. In this work Freud went beyond anything earlier and postulated the presence in all organisms, including man, of a life force which he called Eros, its most obvious manifestation the sexual drive, and a death wish. We – man, snail, baboon, grizzly bear – come into this world with a will to live and a wish to die. When the wish overcomes the will, we have had it.

With this far-out excursion into metaphysics, Freud in time would shake off all but his truly most devoted adherents. And the concept of the death wish, impossible for any biologist to accept, may for all we know have opened the door for equally implausible concepts put forward by younger psychologists. But we should make the gravest of errors if we dismissed Freud's theory simply because it is preposterous. From first to last throughout all his long career, Freud granted the force of instinct in the human psyche. With his newest theory he reasserted his belief in the unity of all living things, and he still saw man as a portion of the natural world. Then in 1924 the University of Chicago's John B. Watson published his *Behaviorism*. Watson believed in neither.

It is an accident of history that Marais recorded his thoughts concerning the human psyche at that moment, in 1922, when psychology's arrow was over the mid-Atlantic,

halfway in its flight from Vienna to Chicago. It left behind a fractured, doubting, bitterly divided remnant of twentieth-century psychology's pioneering band, to fall into the hands of a man who had not a doubt in a single bone of his head. Psychology's pioneers had been human, sensitive, courageous, wild in their wonderings, magnificent in their frailties. They had been artists. Psychology's inheritor was a one-man advance agent for the computer age. For the delicate intricacies of Viennese thought, Watson substituted a meat-hook, borrowed we may assume from a local South Side stockyard. His breath-taking confidence rivalled that of a Karl Marx issuing his Manifesto. Watson's most famous quotation runs as follows:

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in, and I'll guarantee to take any one at random and train him to become any type of specialist I might select—doctor, lawyer, merchant-chief, yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations and race of his ancestors.

In other words, man is born a perfect cipher, bringing nothing into this world but malleability under the pressure of environment. He is invariant, and we need not concern ourselves with individual differences, since every human baby born has precisely the same potential as every other baby born. Talent, intelligence, capacity for leadership or the perfect crime – all are products of learning and experience within the lifetime of the individual. If as adults we vary, it is only because of the varying environmental experiences that have come our way, some adding to, some subtracting from the uniform human potential.

This was Watson's behaviourism. He drew heavily on the work of the famous Russian physiologist I. P. Pavlov, who initiated systematic study of the conditioned reflex. Behaviourism was the perfect psychology for a materialist

society. There is an irony in our supposition that the United States and the Soviet Union live in worlds apart as well as opposed. Both of our societies are founded on materialism – the dialectic materialism of communism, the utopian materialism of capitalism. We must both believe in the omnipotence of the material environment. If we lose that faith, then the Soviet Union must cease to believe that the environment of a perfect socialist society will produce a new and perfect man. If we lose that faith, then the United States of America must cease to believe that in a society of perfect, universal affluence all men will be good and true.

The American dream and the Russian dream are of course constructed of maximum nonsense bearing minimum relation to human reality. And we may speculate that the dream has contributed its incisive share to the deepening and, seemingly insoluble troubles which both super-powers are experiencing today. Most demonstrable is the fact that behaviourism – or environmentalism – dominates the political philosophical, and scientific thought of America and the Soviet Union in equal measure, and more successfully than in any other countries in the contemporary world.

With very slight modifications in the direction of common sense, behaviourism in the United States passed from Watson at Chicago to Clark Hull at Yale to B. F. Skinner at Harvard. No figure in American psychology today rivals Skinner's authority. All over the American academic map there are maverick scientists attacking the postulate of man the born goose-egg, man the uniform replaceable part, man the strangest being in all the animate world, containing no ingredients other than those that his environment has placed in him. Yet the rule of the conditioned reflex remains unbroken. (Today we speak of 'reinforcement theory'.) One of the most influential of American anthropologists, M. F. Ashley Montagu, could recently write, without qualification, that 'man is man because he has no instincts, because everything he is and

has become he has learned to be from other human beings.'

It is a fairy-tale world that was born two years after the writing of *The Soul of the Ape*. It is a fabric of fallacy far more rigid, far more impenetrable, far more wishfully, sentimentally persuasive than the Freudian postulates that Marais deplored. It has become, indeed, a disease confined not at all to the laboratories and text-books of psychologists. Its dogma of human uniqueness and human omnipotence has spread at epidemic pace to infect, to a considerable or great degree, all the sciences of human understanding and much of lay thought as well. If the educated world is in trouble, then the wonder is small indeed. This has been its education.

We have here, then, the broad answer to my original question: What has happened to the sciences in the first seven decades of the century after Darwin's? The answer is as simple as it is brutal: We have lost our way. And so we may find also the answer to the question as to how a lonely man in his lonely work could have been quite so far ahead of his time. Marais did not lose his.

One glimpses few omens of fortune in Marais's obscure life. And yet luck came his way – once. When circumstances combined, just after the century's turn, to place him in the neighbourhood of a huge troop of wild baboons, fortune cloaked him as it had no other man. Even the Boer War, otherwise a force that so darkened his life, brightened the fortune.

In farming country, baboons, because of their persistent looting of crops, are regarded as vermin and a bounty is placed on their scalps. Nature has provided us with no more accomplished bandit excepting only man himself. One must assume that the war between man and baboon has prevailed since the first black farmers, a thousand or more years ago, invaded baboon country. The baboon, no simpleton, has come to the natural conclusion that man is a poor companion. But, as I have briefly suggested, when Marais arrived in the Waterberg, for four years his baboons had heard no gun

fired. Farms had been burned, families taken off to concentration camps, and the farmers themselves had been with the Boer commandos. While Marais continued his studies, the men slowly came drifting back from prison camps to restore their demolished farms. But they had been disarmed. Eventually, of course, they regained guns and ammunition. In the meantime, however, peace still prevailed between baboons and men.

In Marais's day, only the most peculiar of circumstances could have made his observations possible. As he himself suggests, the condition was not quite natural. His troop was larger than any studied recently in the limited areas of African game reserves, and its size was probably due to isolation and low mortality over so many years. The ruling oligarchy of dominant males was necessarily larger. Also, there was a higher ratio of males to females than is normal; it is the irrepressible male who suffers the higher mortality at the hands of man.

I do not believe, however, that any of these slight aberrations affects his conclusions concerning the psyche of the baboon. His was the luck to have available before him, year after year, the repeated testaments of daily life in a higher primate. Freud, with lesser luck, had only theory. Eugène Marais, the damned and the saved, with all his complexities of inner pain and overwhelming insight – so difficult to explain in terms of the conditioned reflex or human uniformity – could gain from long, direct experience materials for his basic conclusion that the human psyche, like the human body, has evolved from the world of lesser animals.

There was still another element of luck in Marais's isolation: his protection from the ups and downs of scientific thought. His faith in Darwin was undiluted. In all charity to Freud – and, indeed, to Watson, though I grant it grudgingly – it must be recorded that in their day the theory of evolution was in bad shape. From 1859, when *Origin of Species* was

published, Darwin's theory remained dominant in all the natural sciences until nearly the turn of the century. But laboratory gremlins were eroding its validity. Natural selection did not seem to work in the fashion which Darwin had anticipated. Many rejected the whole of the theory. Others turned to Lamarck and the inheritance of acquired characteristics. Marais himself was tempted by Lamarck, as letters to his son make evident, but the temptation had no influence on his own theories and does not enter into *The Soul of the Ape*. It was a time, however, of biological trouble from which Marais was fairly well insulated. Not until 1930, when the work of an inspired trio of geneticists – Sir Ronald Fisher, J. B. S. Haldane, and Sewall Wright – founded the new science of population genetics, was Darwin's natural selection placed on an inarguable basis. Today we speak of 'synthetic' evolution – as first synthesized by Sir Julian Huxley – or 'neo-Darwinism' to describe evolution as biologists now understand it.

The wheel came around, in other words, to the number which Marais had originally chosen. But it must be admitted that for those in the midst of the pressure of scientific fashion, evolution did not offer a firm structure with which to deny the validity of false hypotheses. (For those who still cling to them, society can offer little but the benevolence of an old scientist's home.) But there was a far more practical lack than sound theory in the early decades of our century, and that was our total ignorance of the behaviour of higher animals in a state of nature. Until 1961, when S. L. Washburn and Irven DeVore published their paper *The Social Life of Baboons*, with a single exception science possessed no reliable information whatsoever concerning the life of our nearest evolutionary relative, the primate, in a natural state. The exception was the work of the great American psychologist C. R. Carpenter, who, some thirty years after Marais, entered a Panama rain-forest to conduct a systematic study of the

howling monkey. Through the 1930s he followed on with similar studies of the gibbon and the rhesus monkey. They were ignored, as I am assured that Marais's study would have been ignored had it been published in its time.

Tides of fallacy were running too strong to be intercepted by a few rocky facts. We had not in this lengthy period ignored animal behaviour, but we had confined our observations to captive or domesticated animals in laboratories and zoos. One of the most ill-starred events of our scientific century took place in 1932 when Sir Solly Zuckerman – another South African removed to Britain – published his *Social Life of Apes and Monkeys*. The book was a thorough, convincing study of the behaviour of baboons. But the baboons were in the London zoo. That they were obsessed with sex lent support to the Freudian hypothesis. That in Zuckerman's opinion this sexual obsession provided the basic motive for primate society – a motive so different from human society, in which the temptations of fornication are a socially disruptive force – lent support for the notion that 'people are different' which in the coming years would be the bread and meat of a sociology and an anthropology ignoring evolutionary influence on man.

Until 1960 the book stood as a keystone in the tightly constructed arch of contemporary fallacy. Then in 1961 began the new attack of evolutionary thought and techniques on academic orthodoxy. That was the year Washburn and DeVore published their study of baboons in the wild. Even their single study demonstrated that the behaviour of primates in captivity bears little relation to their behaviour in a natural setting. The former is a frustrated being; the latter a busy fellow with much to absorb his energies besides sex. Then through the 1960s came a regiment of scientists observing all manner of primates in a state of nature. All confirmed the complexity of primate life recorded by Marais in 1922. All proved that sexual obsession in the primate is a myth.

Zuckerman's book stands today totally discredited. But social scientists beyond counting remain still uninfluenced by the revolution taking place in the natural sciences.

Biology's revolution began in an inconspicuous way in 1937, the year after Marais died. It was announced by a scientific paper called *The Companion in the Bird's World* by Konrad Lorenz, an Austrian scientist who for years had been observing a variety of birds and mammals at his home in a wild stretch of the Danube shore. It presented a series of highly original hypotheses concerning the relation of instinct to behaviour in animal life. And with that paper the science that did not exist during Marais's lifetime came into being.

Konrad Lorenz is known today as the father of ethology, the rapidly exploding science concerned with the biology of behaviour. C. R. Carpenter's early studies indeed preceded Lorenz's, but it was the impact and continued activity of the Austrian naturalist that brought ethology into being. Closely allied with him in the early years was Niko Tinbergen, who transferred his activities from the continent to Oxford, where he established a pioneering department of animal behaviour. In 1951 Tinbergen's *Study of Instinct* established ethology as a scientific discipline that could be ignored not even by its angriest opponents.

Such opponents existed in plenty. Although the earlier studies by the new ethologists confined themselves strictly to animals, the essential concern with evolution implied that sooner or later we should be involved with the behaviour of men. Still, however, the quarrels remained within the sciences, and not, indeed, until 1966, when by singular fortune the English translation of Konrad Lorenz's *On Aggression* and my own *The Territorial Imperative* appeared almost simultaneously, did the debates of the scientists reach out to a large, informed, profoundly concerned public.

Are there truths about man which have been hidden from our eyes and shielded from the education of our children?

Marais believed so. If Konrad Lorenz is the father of biology's new challenge, then Eugène Marais was its prophet. But before we turn our attention to his book lying before us, we must inspect one relevant scientific development which Marais did not and could not anticipate. It is a final irony in his story – and the story of our times – that in 1922, when he was writing *The Soul of the Ape* in Pretoria, a young Australian anatomist named Raymond A. Dart was arriving at the Medical School in Johannesburg, only thirty-odd miles away. And two years later Dart discovered *Australopithecus africanus*.

Any understanding of the evolutionary nature of man must rest on two sources of information: We must know the world of the animal, gaining insight from it with which to view our own; this Marais pioneeered. But we must also know as precisely as possible the evolutionary course by which, from the condition of the lower animals, there arose that most remarkable of animals, man. This Dart pioneered. But whereas Marais's work remained unknown, Dart's became the focus of a controversy which is being resolved only in the present day.

The problem of human evolution may be stated simply: When Raymond Dart discovered the fossil remains of a being who lived on the African savannah over a million years ago, who was a hunter following a carnivorous, predatory way of life, and who resembled man in every way except in brain-size, about a third that of ours, he upset almost every preconception – philosophical, religious, biological – concerning what the human ancestor should be like. Since the time of Darwin we had assumed that our primal ancestors must have resembled the shy, inoffensive, vegetarian ape of the forest. I know of only one thinker, the British psychologist Carveth Read, who departed from the universal assumption. In 1920 he published his conclusion that our pre-human ancestor should be called *Lycopithecus*, for his way of life must have

been similar to the way of the wolf. Nobody paid any attention to Read. Then four years later Dart found the creature.

We speak of such predecessors as hominids, a primate line evolving independently of the lines of the ape and the monkey. When Dart claimed that his australopithecines were true hominids, that we lived in bands systematically and effectively killing for a living, and that we used tools and weapons long before the development of the enlarged human brain, all combined to produce a bad case of scientific indigestion. Today, at last, his case is all but closed. In late 1967 Alfred S. Romer, the world's foremost paleontologist, wrote that 'with one or two exceptions, all competent investigators in this field now agree that the australopithecines of the early Pleistocene are actual human ancestors.'

The question before us today concerns not the legitimacy of our carnivorous ancestry, but its antiquity. And it is the work of that Christopher Columbus of human evolution, Kenya's Louis S. B. Leakey, that we shall probably find the answer. The 1960s, which have witnessed the explosion of discoveries in the area of animal behaviour, have witnessed a simultaneous explosion in our knowledge of the human past. I shall not detail the rapid advance, but merely describe the most recent of discoveries, announced only a few weeks before the writing of these pages. In May 1968 Leakey delivered a shock that will probably once again put science into a time of trauma. At a site near Fort Ternan, in East Africa, he had been studying a creature whom Leakey calls *Kenyapitchecus*, and who was probably ancestor of the australopithecines. There, in the midst of a fossilized bone-pile to rival those of their descendants, Leakey has found stones used to smash up antelope bones in order to extract the marrow. By modern techniques of radiogenic dating, the time may be reliably fixed at between twelve and fourteen million years ago. Dart's australopithecines were but yesterday.

The antiquity of the hominid hunting way – aside from

all its implications in terms of human behaviour – separates our evolutionary track from that of the vegetarian ape or monkey through an acreage of time quite beyond our limited powers of imagination's survey. And so in reading *The Soul of the Ape* we must avoid at all costs the easy pitfall of equating the amiable nature of the chimpanzee or, indeed, the aggressive behaviour of the baboon with facets of human behaviour. We are all endproducts of quite varying evolutionary tracks, quite varying conditions of survival. But we are of the same primate family. And – all-important – we are all of us products of the same evolutionary process.

Eugène Marais could not know what future sciences would reveal concerning the distinctiveness of human evolution, mediated by that long-surviving hominid, the wolf-ape. Dart's early discovery was too lost in controversy, too late in Marais's declining life, to have influenced the course of his thought. And it is our fortune, as well as his, that his concern with psychic evolution was so profound as to be applicable to us all – harmless ape, belligerent baboon, killer man.

'His was the first human mind to penetrate the secrets of the wonderful world of the animal, and to apprehend the legitimate mysteries of the wonderful world of man.'

I wrote these words in *African Genesis*, and have now neither reason to modify them nor inspiration to improve them. Marais was not the first thinker to glimpse in Darwin's theory implications concerning the continuity of our evolution in factors other than body. In *Les Sociétés Animales*, Alfred Espinas attempted to demonstrate the gradual transition from animal to human societies, but his ideas were dismissed to oblivion by the master sociologist Emile Durkheim. Carveth Read, as we have seen, took a hard look at the history of human ferocity and forecast with chilling accuracy the wolf-like nature of the human ancestor. None before Marais, however, had the living materials of nature to guide

him. And none before Marais had the audacity to peer into the inner recesses of the primate mind, and to draw from his observations conclusions concerning the continuity of evolution of the human mind itself.

The bewilderment of man is the bewilderment of all higher primates. Mind was the essential blessing bestowed by the accident of mutation on the earliest of Eocene primates perhaps sixty million years ago. We differed, otherwise, little from rodents. But since at this date we were all of us arboreal, we developed hands instead of paws, with fingernails to protect sensitive fingerpads so valuable to a life in the trees. And we had the social inclination; not since the most primitive of lemurs do we find a primate species of solitary disposition. But the brain was our hall-mark. If the primate was to succeed as a natural experiment, then he must succeed by his wits.

Thus by whatever evolutionary track we proceeded – the ape and most monkeys in their forest setting living off forest foods; the baboon and a few other terrestrial monkeys, like the patas and the vervet, living an all-fours life largely in the open and eating a far greater variety of foods; or the advancing hominid with his bipedal posture, his hands freed for the use of weapons and tools, his diet more and more dependent on the fruit of his kill – in all we find the pressure of natural selection favouring the better brain, and the better use of what brains we had.

The psychic dilemmas of hominid and baboon – both of us citizens of the dangerous savannah – can with little likelihood have included qualitative differences. We both in our most ancient origins had been largely guided by the confidence of instinct. Learning, we must recognize, plays a part in all animal life: the amoeba can 'learn'. Such learning, however, for the most part reinforces instinct and adapts its inherited directives to circumstances of time and place; it is still instinct that guides. But in the progressive primate, and

in many predators as well, such ancient wisdom fixed in the genes was not quite good enough. And so there developed the conflict, as Marais saw it, between the 'old' mind, the inherited animal mind, and the 'new' mind developed in the individual by experience.

The new mind would make possible the human achievement of adaptation to almost every environmental condition the earth has to offer. If genetic wisdom could offer us no information as to how to meet some new state of affairs, then experience and learning would succeed. But, as Marais sets forth, the baboon, like man, has so succeeded. He has accepted all manner of climates, of conditions of survival, of enemies, of existence on lush plains or forbidding deserts, in mountain fastness or tempting valley. Like man, the baboon thrives on anything that passes for food. Marais knew of troops that killed lambs to gain the milk curd from their stomachs. He knew of none that ate meat. But in recent years we have found areas in East Africa where baboons have crossed the Rubicon that the hominid once crossed and prey systematically on the gazelles' newborn fawns. The baboon has faced everything, including the implacable animosity of man. Yet he survives as the second most successful of primates, surpassed only by ourselves.

I suspect that it was Marais's attention to traditions of behaviour varying from troop to troop that presented him with his first hard evidence for the significance of the new mind in baboon life. This forms a major scientific contribution in *The Soul of the Ape*. Even in studies of most recent years we have been far too preoccupied with forms of behaviour common to an entire species – what we call species-specific – and are therefore probably under genetic control. That we find in man such varying traditions of behaviour in different peoples has been a principal argument on the part of those who see the human species as differing radically from subhuman animals. Marais nullifies the argument with

his careful documentation of varying traditions in baboon life.

A chief function of any society, human or subhuman, is education. Sir Arthur Keith once described education as the first industry of any species; should the industry fail, the species will become extinct. Few higher primates centre their social life on the family. And so, with their slow-growing young, education is mostly accomplished through the traditions of the entire troop. The young learn from their elders what the elders when young learned from theirs; and so, whatever the wisdom gained from experience the troop may possess, it is handed down from generation to generation. Man may have the immense advantage of the oral or written word. But the process is the same.

I cannot believe that Marais would have been surprised that Japanese scientists, in their superb studies of the Japanese monkey, have found among ten troops three in which high-ranking adult males invariably take charge of all year-old infants when mothers give birth to new babies; three in which the tradition is sporadic; and four in which it never occurs at all. In terms of the natural selection of groups, the first three troops have developed a tradition which through reduction of infant mortality is of superior survival value. And a thousand years from now, if there is still a Japan with Japanese monkeys, what is today a social invention may have become a tradition common to the species.

Obsolete information, cluttering the minds of those who speak for human uniqueness, still tends to inform us that there is a sharp line between animal and man because the animal is guided by rigid instinct, man by flexible rational powers. Both propositions are false. Our developing knowledge of human evolution must tell us that so gradual was our coming, no clear moment could ever have occurred when before it we were animals and after it, men. And any honest appraisal of the human being – any ruthless inspection of

one's own inner self – must inform us that we are guided again and again by impulses lying deeper and more powerful than our rational determinations. Man has his instincts. So it was that Marais exposed the other side of the psychic coin: the baboon, a primate of quite undistinguished brain as compared with the chimpanzee, must still gain most of his directives for living from his power to learn.

Human Aggression, a recent book by the London psychoanalyst Anthony Storr, presents better than any other published thus far the evidence for man's hidden animal nature. And *The Soul of the Ape*, though written so long ago, presents better than any book published thus far the dawning humanity in the psyche of the higher primate. One cannot be so innocent as to presume that the two books together will forever destroy the mythical line between animal and man; but one may modestly hope to see damage done.

Marais's observation of the role of learning and tradition and consequent varying behaviour in the life of the baboon is thus a major advance in our new evolutionary literature. His central contribution, however, is of course the book's central hypothesis: the evolutionary origins of the unconscious in man's mind. For this contribution we have little precedent.

If one has groped through the existing scientific literature devoted to instinct and learning, then one must grasp with relief at Marais's invention of two simple phrases, *phyletic memory* and *causal memory*. By this I do not imply that they can be swallowed without a bit of chewing. But phyletic is not too difficult a word. In biology we refer to phylogeny when we speak of the history of a species and its antecedent species, as we speak of ontogeny to describe the history of the individual. A phyletic memory, then, is one whose cause we are unaware of, since the memory itself is carried in our genetic make-up as a result of evolutionary crises long ages past.

Let us think, for example, of some ancestral baboon species

recently emerged from the life of the forest. Apes and arboreal monkeys have as a rule loose social organizations. But on the savannah the baboon met lethal dangers rare in the forest. Even the small-brained hominid himself, to judge by the fossil remains of his kitchen-middens, had a hearty appetite for baboon flesh. Now, the baboon is a powerful animal, but even so his only defence on the savannah lay in concerted social action. Those troops that kept to their undisciplined ways met disaster. Only those capable of leadership, willingness to obey, and cooperative defence could survive to leave descendants.

The hamadryas is an aberrant baboon species with its own desert ways. But in all other species, throughout the passing millennia, the basic baboon society took form. There is a group of powerful males who never quarrel, who enforce order in the troop, and who assume the most dangerous responsibilities in the troop's defence. And there are all the other members who submit to authority and do their part. The leaders may be three in a troop of eighty and could be overwhelmed by revolution tomorrow. But it will not happen. Phyletic memory inhibits the impulses of the many with its genetic wisdom derived from ancient happenings, just as it commands the actions of the few to go forth at all risk and face the cheetah.

Phyletic memory forms the unconscious portion of the baboon psyche. Causal memory is the conscious portion, the learned portion, the portion springing from experiences within the baboon's lifetime. As Marais saw them, the two exist side by side, or, more accurately, the old beneath the new. And the story of psychic evolution has been the gradual ascendancy of causal memory over phyletic. Yet never does the one wholly succeed in displacing the other.

Turning to Marais's investigations of the phyletic memory in man, the startled reader may be wary of conclusions drawn from hypnosis. But we must recall that Freud too used hyp-

nosis as a technique in his discovery of the unconscious mind. Sir Julian Huxley, in *Essays of a Humanist*, writes: 'One of the darker chapters in the history of science and medicine is the way in which pioneer hypnotists were attacked and often hounded out of the medical profession. Even today, there is still a great deal to be discovered in this strange and exciting subject.' Just how strange it may be is illustrated by an experiment at Pennsylvania State University reported as recently as 1968. A group of college students were hypnotized and told that they were nine years old. Each was then instructed to write a letter to a friend. The letters were then mixed with similar letters written by legitimate nine-year-olds, and all were presented to a faculty committee that knew nothing of the experiment. The letters by the hypnotized college students and those of the true nine-year-olds could not be distinguished on any basis, whether style, content, or handwriting.

Contemporary theories of learning tumble in the face of such an experiment; and it is not impossible that hypnosis was placed beyond the scientific pale because it asked more questions than our sciences could answer. Such a fate befell extrasensory perception. But in Marais's day hypnotism was still regarded as a valuable and legitimate tool. If in our day it is very nearly taboo, then we may comfort our suspicions by reflecting that, strange though hypnotism may be, the ways of science can be stranger.

Phyletic memory is Marais's term for what we should call instinct. Yet the word instinct is so loose, so difficult to explain or define, so surrounded by controversy, and so subject to manipulation by those who would justify the worst or the best in human behaviour as instinctive, that many authorities refuse to use it. Marais, it seems to me, has provided us with a superior term for a quality in life which, if we cannot explain, we still cannot deny. With his phyletic memory and his causal memory he described two psychic forces cleanly

and with sufficient definition to permit his investigation of the evolutionary origins of the conscious and unconscious minds.

Marais, as I have indicated, saw phyletic and causal memory as existing apart, with the latter increasingly dominant over the former. They may, however, combine. Ethology is aware today of many forms of behaviour which, while having a genetic basis, require learning to become activated. Such is the behaviour of a robin defending his acre, or a man defending his home. Both have ancient phyletic memories that possession of an exclusive territory forwards the survival of adult and offspring. But causal memory must help robin or man in gaining a territory, knowing its boundaries, its resources, and the character of potential intruders, or the pattern of behaviour will be incomplete.

Causal and phyletic memory may form alliance in another fashion, and perhaps it might be useful in our own thinking to retain a distinction between the unconscious and the subconscious. The truly phyletic memory would then be the true unconscious, something beyond any recollection since its causes lie buried perhaps tens of millions of years before the birth of the individual. But in deference to the psychologists of Freud's generation as well as to our own commonplace experience and observation, we must recognize the existence of a murky half-world, the subconscious. Here repressed causal memories sink, to join with rising phyletic memories to form powerful unions distorting or vetoing the rational procedures of the causal mind. But there is a difference from the true unconscious. These unremembered memories, being causal, have their sources in the lifetime of the individual. And so, whether by psychoanalysis or other tools, they may be probed and, if we are lucky, brought back into the realm of rational disposition.

Let us take an example: Konrad Lorenz has demonstrated that no organism lacking aggressiveness has the probability

of living to maturity and reproducing itself. Anthony Storr has applied the Lorenz principle to human life. We may therefore regard aggression as one of the most powerful of phyletic memories. But aggression in human life may take many forms, from the painting of masterpieces to the competitions of businessmen to the killing of strangers. Now let us assume that we live in a society that praises selflessness, condemns aggressiveness, provides few outlets for its healthy display, and instils in us a sense of guilt concerning temptations and experiences in themselves quite normal. May not such causal memories – perhaps of the excitement of violent action acquired in early childhood – be forced by guilt into our subconscious, there to form union with phyletic command and to lurk in our depths like Lalele? May not such a social attitude, judged in the terms of a future psychology, accomplish the precise opposite of its objectives?

There are few areas of human life, few moments of human decision, to which *The Soul of the Ape* does not bring a measure of clarification. I have said that the bewilderment of man is the bewilderment of the animal; and I firmly believe it is so. We are caught, all of us, at our differing levels of psychic evolution between the opportunities of the new mind and the commands of the old. And perhaps in the end it will be recorded that we were all tragic species playing out the successive charades of a natural experiment called the primate, in which the last terrible writing on the wall was inscribed by the dainty hand of some forgotten lemur in the long-lost Eocene. It need not, however, be true.

Man today has reached a bewilderment that no ape, no monkey could envy. But we have something that, so far as we know, they have not: self-awareness. We have the power to investigate ourselves. And however foolishly we may use that power, denying by our folly even our rationality, still the power exists. The evolutionist, looking wryly about at a world that sweet reason has produced, may well conclude that

the efforts of the individual must in the end prove futile: man makes no sense. Yet while he could be right, he would also be wrong. Man may make no sense, but evolution does. And if through our self-awareness we can come to an understanding of ourselves and our place in nature, then through a simple faith in something far larger than ourselves we may find a hope which we so singularly lack today.

Perhaps a sense of individual futility was too strong in Eugène Marais. Perhaps causal memories of misfortune made union in his own subconscious with the phyletic memory of the monster Lalele. Perhaps his tragic sense as a poet overcame the creative optimism of the scientist. Perhaps he was a man born too soon, and knew it. Or perhaps it was nothing at all so large, so profound, but that in an hour of inspiration he returned to his labours on *The Soul of the Ape* and found, as the weary months slogged by, that he was not too soon, but too late, too late. And so he blew himself to pieces with a shotgun on a farm near Pretoria.

We shall never know. Nor does it matter that much. His manuscript is rough. It lacks a proper conclusion. In certain areas of his argument one longs for further demonstrations, for those more detailed observations which he could undoubtedly have supplied. Had Marais, in the southern autumn of 1936, been enabled to finish his manuscript, polish the rough parts, re-think a few conclusions, add further ideas that had come to him in recent years, then beyond all question he would have left us more than we shall find in the following pages. But he left us enough. He gave us certain imperishable thoughts still new and useful in a time of human crisis. And he gave us something else: the memory of his own life, in itself an imperishable testament to the awesome wonders and the legitimate mysteries of the being called man.

R.A.

I

MEANS AND METHODS OF RESEARCH

SHORTLY after the War, I had the opportunity of living for three years in very close proximity to a troop of wild chacma baboons (*Papio Ursinus ursinus*). During that time a register was made of all the adults – or nearly all – and it was thus possible to study their behaviour under very favourable conditions. During most of this time I had the invaluable assistance of a young friend and countryman who, under the most disadvantageous circumstances, had attained a remarkable knowledge of the higher African mammalia and their comparative anatomy. An untimely death unfortunately cut short his work.

The conditions under which this investigation was made were, in some respects, ideal and are hardly likely to recur in South Africa. We were living in a high, narrow valley between two parallel ranges of the central mountains of the Waterberg in the Transvaal: a stream flowed down one side of this valley and found an outlet through a gorge in the southern range. The floor was strewn with piled-up fragments of conglomerate rock which, in the course of ages, had been dislodged from the hills to shape the faces of the precipitous walls of the gorge. Both floor and walls were thickly overgrown by big timber-trees and tree-ferns. Plants grew and thrived wherever the smallest root-hold had been gained either in the soil or in the living rock. Along this gorge the stream had worn for itself a very much impeded channel to the low country.

On the right side, about a hundred feet from the floor of the gorge, the face of the cliff was split by a huge level-floor

cavity. Just below this cave, against the wall of the precipice, grew a giant wild fig tree, its roots widespread over the face of the rock and its enormous branches and dense foliage completely sheltering the mouth. A slope of loose rock, which was comparatively easy to climb, stretched down from one end of the cave entrance to the floor of the gorge. The cavity formed the sleeping place of a troop of baboons.

The circumstances which rendered these clever and extremely nervous animals indifferent to the presence of their arch-foe, man, were due to a long succession of events. The War had left the area in unpeopled solitude for a number of years and, when eventually the families returned, the men were for several more years without rifles or ammunition. The baboons were very quick to realize the helplessness of their neighbours and took full advantage of it. The orchards, gardens and grain lands were raided with incredible fearlessness.

On our arrival in the valley and during the construction of our huts near the entrance to the gorge, the babies who could walk and all the youngsters of the troop showed an insatiable and often reckless curiosity, much to the alarm and disapproval of their elders. Perched on stones within thirty yards of us, they would follow with the closest attention all our movements. These quiet times occasionally gave place to rollicking games, one of which was to approach us in a rush up to the sticking point of their courage, and from that comparatively safe distance they would indulge in the customary baboon 'face pulling' and threatening grimaces, or assume the attitude of conciliation.[1]

The older individuals were at first very chary of approaching us. They would remain on the slopes of the hillside, nervously calling to and 'warning' the more intrepid youngsters, and occasionally a big male would wake the

1. This attitude is referred to at length in the chapter dealing with sexual abnormality.

echoes of the mountains with his tremendous voice. We experienced a great deal of difficulty in overcoming this distrust in the adults. It was my colleague who by infinite tact and patience eventually gained their confidence to such an extent that they assembled daily for several months in the immediate vicinity of the huts, where they were fed on mealies. We were thus able, in time, to approach within a few yards of them, and it was then apparent that it was we rather than the chacmas who needed to be distrustful and continually on guard. We were never actually attacked, although dangerous threats were a daily occurrence, and of such a nature that in the beginning one of us had always to be armed.

But a better understanding was gradually established as we got to know each other. Eventually the baboons allowed us to climb up the slope of their sleeping place in the evening and very early morning and watch them from the roots and branches of the big fig tree. They would never, however, permit us to set foot on the floor of the cave itself. Any such attempt was at once, even in the night, countered by a threatening advance on the part of the big males, who clearly 'meant business'.

We kept a number of tame adults and babies, some in captivity and some at liberty, at a farm-house below the mountains. We also had in captivity at different times wild adults that had been wounded by scalp-hunters[2] and captured alive. The behaviour of these captive baboons was studied for a period not exceeding three years.

Ideal as conditions were in one respect, we still laboured under disadvantages that were not without effect on our work. The greatest of these was – it appeared later – the want of time. As the neighbouring farmers regained possession of rifles and ammunition, observation of the troop became more and more difficult and all too soon was rendered quite impos-

2. The Transvaal Government paid a bounty of five shillings on every baboon scalp.

sible. Another serious disadvantage was our isolation: we had no libraries and no means of checking what work had already been accomplished in this field.

In this connection I would like to mention our own attitude towards the exploration of these twilight souls. We approached this investigation without any preconceived ideas, and although at the beginning inexperience may have left much to be desired in our methods, we had at least no theories to verify. We tried always to adhere to the empirical method and to avoid as far as possible the shadowy by-ways of metaphysical speculation and psychological abstraction to which research in this field seems inherently inclined. We also decided against setting ourselves an exclusively anthropomorphic criterion; but this proved to be more attractive as a theoretical basis of research than efficient as a practical means of avoiding error.

It is true that a continual reference to human mentality is not the ready highway to truth that it seems to be at the first glance. There are profound – and, to the believer in the theory of continuous mental evolution, even startling – differences in the lesser eddies of the psychic stream. The great current is beyond doubt the same in kind, however much it may differ in volume and intensity, but it is in these lesser eddies that the significance becomes obscured by a continual reference to human psychology. This we realized clearly. On the other hand, these differences excepted, the mental processes of the chacmas are generally so human-like that it proved impossible to submit them to a critical examination without accepting as a standard our common human experience.

It is necessary to state that the environment of this wild troop cannot be described as quite natural. They were completely isolated and had evidently been so for many years; the intrusion of man as a dominating element added other profound effects to those of unnatural isolation. In a systematic

study of behaviour these particular conditions would have been an advantage had it been possible to compare the habits of the chacma we investigated with those living under more natural circumstances. But there were two great difficulties preventing such a comparison. The first was the problem of finding any troop where the reaction to man's intrusion had not created habits that would not have existed in his absence, and the second was the supreme difficulty of observing closely and continuously any troop not so circumstanced.

We did, however, observe some other wild troops under more natural conditions, as will be apparent in this record of a small portion of our work, which is basically an attempt to interpret some of the actions we studied in our troop compared with others less isolated, rather than a detailed description of the chacma's behaviour.

2

HABITS ACQUIRED IN DIFFERENT ENVIRONMENTS

AN outstanding characteristic of the chacmas is their ability to thrive in the most varied environments. They are equally at home on the fertile mountains of the Cape and in the sterile hills of our more northerly terrain. In the Cape they are in the midst of a plentiful and varying food supply. Here, as Darwin has pointed out, the proportion of different species of plants to the extent of soil area covered is greater than in any other continent, and no less plentiful and varied is the insect-life. The mountain-masses of the Cape afford, therefore, a safe retreat in the midst of thickly populated districts, and their protective value is chiefly due to the fact that natural fertility renders it unnecessary for the baboons to engage in the dangerous expedient of exacting contributions from the farms of their human neighbours.

It is hard to imagine an environment more different from this land of plenty, with regular rains, sheltering caves, precipices and forests and perennial mountain streams, than the rugged, sterile hills of the north, where existence has become an unending struggle for the chacma. Not only is his life more instantly jeopardized on these low and shelterless hills by the presence of man, but the question of a sufficient food supply has become a complex problem. Yet even here the chacma thrives under conditions which would, I should imagine, have brought about the extermination of any other species of gregarious mammal. Indeed, many great species of mammalia have been exterminated in this country under conditions far more naturally favourable.

But there is an even more profound difference in natural

environment than the one created by difference of locality only. It is beyond doubt that the great majority of the species have only in recent times ceased to be arboreal animals and have migrated to the hills and mountains under pressure of defensive necessity and have become purely mountain animals. There are instances where such migrations have taken place within the memory of man. But this change in natural habitat has not been universal. Along the great riverways of South Africa in the less populated regions, there are still great numbers of baboons inhabiting the forests, where they live as largely arboreal animals.

It will be realized how very different their habits and general way of life must be to render existence possible under two such radically different sets of natural conditions. The 'tree' or 'river' baboon is popularly spoken of as a distinct variety of species, a designation which has no other foundation than these greatly divergent habits. These different habits are not determined only by the difference in the natural food supply or by the difference in environmental dangers; they are brought about by conditions which affect the entire existence of the animal in its relation to nature. They differ no less profoundly in some of their habits than, for instance, the klipspringer (*Oreotragus saltator*) and the steenbok (*Neotraginus*). None the less, they are the same species, and there is no morphological reason for describing the river baboon as a 'local variety' in the generally understood sense. Nor is there any hereditary limitation to one environment, as there would be in all lower animals similarly placed. We established experimentally that if an infant arboreal baboon is given to a mountain troop, it is adopted and grows up with the complete knowledge necessary for it to exist in its new environment.[1]

Among the higher vertebrates the nature of their food supply is certainly a great element in determining the course

1. The reverse was not proved.

of psychic and morphological specialization: the aardvark (*Orycteropus afer afer*) – an animate digging machine, toothless, with its long sticky tongue, its wonderful instinct for locating deep termite nests in hard soil; the remarkable bodily structure of the giraffe; the conversion of the flying wings of the penguin into paddles – all were modifications selected primarily by the adoption of a special food supply, and this is the case in most higher animals. It seems also to be a general rule in nature that any sudden change of environment involving the loss of natural food supply – although food for which the organism has not been specialized may be plentiful in the new environment – means destruction.

For instance, the South African otter can, in captivity, subsist on warm-blooded terrestrial animals exclusively, without ever entering water, and yet several instances came to our notice where otters were driven by drought to take up their residence at shallow inland pools without fish or crabs, and they invariably died of hunger, although small terrestrial animals abounded in these drinking places. It is hardly conceivable that structural modification in this case rendered the capture of sufficient animals to sustain life impossible. It was 'instinct' that stood in the way.

This example emphasizes the fact that the psychic specialization is generally more powerful in confirming an animal's reaction to a definite environment than correlated somatic modifications. It is true that species outside the order of primates have been known to adopt new habits because of radical change of food, but all the instances I know of clearly resulted from certain definite influences that are not present in the chacma.

In this country the rhinoceros-bird, which used to relieve the now vanished thick-skinned game of ticks, has undertaken the same office for the thinner-skinned domestic animals. The removal of a tick from cattle frequently leaves a small open wound, and in such cases the bird eats the exposed

flesh, often causing severe, if not fatal, injuries. From this habit it was an easy transition to the practice of attacking any open wounds on cattle. The Australian parrot which has taken to picking holes in the backs of sheep is similar. It is said the habit originated in a resemblance between the wool of the sheep and the covering of a fruit commonly eaten by the bird.

In these few instances, one principle invariably underlies the change of habit: the suggestive influence on the hereditary instinct directly conveyed by a natural food. In the chacma no such connection can be traced in the majority of new food-habits.

The natural food of the chacma consists of fruits and insects. I know of no verified instance where, under natural conditions, the flesh of warm-blooded animals is habitually eaten.[2] Now if any two extremes of locality inhabited by the chacma are considered, it will be found that the species of insects and fruits which constitute their principal food supply vary greatly and, although the nature of the supply is identical, the means of utilizing it differ more profoundly than in any other lower animals, however widely dispersed. But, in addition to these varying methods of procuring natural food, what may be described as supplementary habits have been acquired in different localities which are altogether outside the order of nature – as one conceives that order to exist in the case of the higher mammalia – habits which at once place the chacma in a class by itself. It is necessary to refer to only a few of these personally verified habits in order to convey an idea of the singularity of the animal in this respect.

The southern limit of the baobab tree (*Adansonia digitata*) is the far north of the Transvaal, where it grows to a great

2. In captivity they easily acquire the habit of eating cooked meat, as also they frequently acquire an inordinate craving for tobacco and alcohol.

height and size, dominating the entire forest. It bears a fruit containing a sub-acid pulp popularly valued as a febrifuge and for making cooling drinks. This fruit is doubly protected, for it grows at such great height from the ground that until it drops, only birds and arboreal animals can reach it, and its outer shell is so hard that it resists all attacks. I know of no animal that under natural conditions can reach the edible core or habitually use the fruit as food. The chacma was the one exception.

A troop we had an opportunity of observing travelled great distances to reach the isolated baobabs that are scattered through the Bushveld. The country between the trees and the group of hills they inhabited was generally sandy and stoneless. They would pick the fruit and carry it for great distances to the foot of the hills, where the nearest stones were situated. The fruit is about the size of a small coconut, and the means the chacma adopted for carrying it to the hills was very interesting. The adults generally carried four: one held in the teeth by the stalk on which it grew, one under the right arm, and one in each hand, the animal treading on those held in the hands. We never saw fruit carried under the left arm. On reaching the hills, the fruit was placed on a flat rock and smashed with stones. My colleague noticed that in many instances, particularly among the younger individuals, great efforts were first made to break the fruit by hammering it on the rock by hand before a stone was used as a tool. Often all efforts would fail to break the fruit. It was then rolled off the rock and never touched again. In no other locality we visited where these trees grew did we come across this habit.

This group in the Magalakwên Valley had also acquired a habit which evinced just as high a conception of means to a definite end. They inhabited an isolated precipitous group of hills about five miles from the river. At the time we came in contact with them a prolonged drought had dried up all the

springs and drinking places in the hills; and the nearest water they could reach was in the river bed; even here the only means of reaching it was by digging deep holes in the shifting sand. To get to the river bed they had to traverse a very exposed tract of country and cross a big road, the sort of journey to which the chacma is decidely averse.

Very often the presence of human beings in the vicinity meant the baboons had to go without water for several days, or jeopardize their lives in reaching it. But we found the hill-sides strewn with the chewed fibres of a bulb which proved to be that of a lily which contains a great deal of moisture. The bulb grows at a considerable depth, generally under stones or in soil which in drought is almost as hard as stone. A long rush-like leafless stalk grows out of the bulb and, after a number of twistings underneath and past stones, reaches the surface. A slight pull at this stalk detaches it from the bulb or breaks it deep down, and once it is detached it is almost impossible to find the bulb by digging. Not only had the troop of chacmas discovered that this bulb would assuage thirst, but their method of reaching it showed that they fully appreciated the chief defensive attribute of the plant, and used the only means of overcoming it. In digging they were careful not to detach the stalk, but dug down round it, removing the stones, and so tracing it to the bulb. We never saw this bulb dug up or chewed anywhere else. In the vicinity of our own troop which we kept under continual observation, the plant was plentiful but it was never used by the baboons.

No less remarkable is the habit which has gained for the chacma a notoriety which was perhaps the chief reason that induced the Government to place a price upon its head. The animal is no flesh eater and no bird or mammal is ever killed for food, yet throughout the sheep districts of the Cape a great many young lambs are killed by baboons. The flesh is not eaten; their only object is to secure the curdled milk from the stomach. Here in the northern Transvaal the habit has

not been acquired. No lamb is ever touched although a troop may be in contact with flocks of sheep almost daily.

Another troop which we had an opportunity of watching for a day had discovered a similarly 'rational' method of overcoming an environmental difficulty. The presence of man in their neighbourhood had left them only one drinking place that could be visited with any degree of safety. This was a thermal spring. The water in the spring itself and for some distance downstream was too hot to drink, and a farmhouse, towards which the water flowed, made it dangerous for the baboons to go farther downstream. But whenever they were satisfied that danger from the farm was not too threatening they visited a spot where the water was drinkably cool. Very often this was impossible for long periods, as the farm-lands extended right up to this place and men were working in the vicinity. The baboons were then compelled to find water in the spring itself or immediately below it. On the occasion we observed their behaviour about a third of the troop lined up along the water course below the spring and each one scooped a furrow through the mud. When these furrows were filled with water they moved farther up the hill-side to wait for it to cool.

The larger portion of the troop, agitated and uneasy, did not approach the water at all while these operations were going on. They awaited the results of their friends' labours at a safe distance. Those that took part in the operation of making the furrows consisted of about equal numbers of adults and young ones, and the difference in their respective behaviour was interesting. The adults went about the work quietly, methodically and phlegmatically, after the chacma manner, but the youngsters were greatly excited, jerking out the mud erratically, and frequently, when the hot water came in contact with their hands, uttering cries of rage.

After about an hour's wait on the hill-side, the whole troop again approached the water and commenced drinking out of

the furrows. We noticed that only a very small percentage of these were used and each baboon quietly waited his turn to drink. The reason became apparent on closer examination. The mud was generally so soft that many furrows were soon obliterated and only those dug in the firmer area lasted long enough to cool the water. But even the majority of these could not be used because they were made the wrong way. Whenever the furrow was dragged in a more or less downstream direction, the continual entrance of hot water prevented cooling. A small proportion were scooped out more or less upstream or at right angles to the current and in these the water cooled more quickly. Whether the correct method was adopted by accident or design it was impossible for us to establish, since we had no opportunity of ascertaining whether the same individuals always adopted the same method of construction.

It needs no wide systematic knowledge of animal behaviour to recognize the great difference there is between habits such as these and the greatest adaptability conceivable in animals below the primates. No other animal, under any circumstances, would or could behave in exactly this way, although it might prove difficult to define in other than general and unmeaningful terms the real nature of the difference. And without an appreciation of the significance of these peculiarities it will be found difficult to form a satisfactory conception of the chacma's place in the scheme of mental evolution.

3

PHYLETIC AND INDIVIDUAL MEMORY

WHAT is the essential nature of the mental process which the chacma thus translates into behaviour?

If one traces the shadowy occurrence of mental processes in non-primate mammalia and their even more indeterminate appearance in birds, it is obvious that they are far less complex than in the primate. But such comparison does make it possible to form a clear conception of the real nature of the primate's mental process. If we look at the development of mental processes in the primate from one point of view – namely, in relation to the animal's struggle for existence – it is apparent that the process is fundamentally one of memory – memory in the human sense. It is not merely the memory of things in relation to locality, which even insects possess to a high degree. It is the ability *to memorize the relation of cause and effect*. It is the ability to accumulate what may be termed individual causal memories.[1]

Whatever complexity this mentality may have attained in the primate, evidently the ability to accumulate individual causal memories was an early attribute singled out in the process of natural selection. In the chacma it has become dominant. Individual causal memory generally governs the animal's behaviour in relation to its environment.

Much of the behaviour of higher non-primate mammals is

1. I do not think it is necessary to enter into an abstract psychological analysis. References to behaviour will constantly be made which will make the conception clearer than attempted definition can at this stage.

determined by 'instincts.' These are grouped round three great psychic centres:

1. Sexual sense (reproduction and care of the young);
2. Fear of death (counteracting common environmental dangers); and
3. Procuring of food.

These instincts are nearly always correlated to specific somatic modifications, as in insects.

Purely instinctive behaviour is quite determinate in character. The animal cannot voluntarily vary its behaviour. It meets the normal conditions of its environment in a certain definite way and cannot adjust its actions to overcome the hostile element in any unusual environmental occurrence. Instinct in its purest form may therefore be described, from an evolutionary point of view, as a hereditarily established tendency to certain definite behaviour selected as a reaction to, and as most beneficial under, certain normal environmental conditions.

It seems hardly possible to speak of instinct in terms of the higher-primate mentality. They are probably not related functions and it is possible that pure instinct may be described as 'psychic' only in the sense that it employs, and in a similar manner, the same motor mechanism which the indeterminate mentality makes use of, and that both function through the central nervous system, though quite certainly in different centres. Notwithstanding this, it would still be convenient to speak of instinct as phyletic memory. There are many analogies between memory and instinct, and although these may not extend to fundamentals, they are still of such a nature that the term phyletic memory will always convey a clear understanding of the most characteristic attributes of instinct.

In explanation of my definition of instinct, it must be

pointed out that every set of muscular actions originally evolved in an organism by its environment must be either advantageous or disadvantageous. The organism that engages in such reactive muscular movements as would give it a better chance of surviving would retain that chance only by constantly making similar movements under similar conditions, and so certain definite actions become selectively established. That seems to have been the evolutionary pathway of instinct.

Let us turn now to the operation of these two types of mentality – phyletic memory and individual causal memory – in nature. The analysis of mental behaviour which they respectively dominate will give a better idea of their real significance in the scheme of organic existence than a great deal of explanation. For this purpose I shall select behaviour of three types, illustrating three different stages in the pathway of mental evolution:

1. An organism whose behaviour is entirely governed by phyletic memory; for whom the acquisition of a single individual causal memory seems an impossibility.

2. The behaviour of an animal in which phyletic memory is still dominant, but in whose action there is a suggestion of the new individual causal memory.

3. The behaviour of the chacma under analogous conditions; that is, a mentality in which the individual causal memory has assumed predominant control.

BEHAVIOUR GOVERNED BY PHYLETIC MEMORY

The road-making ants of Africa make pathways extending sometimes to a distance of 300 yards from the hole that leads to their underground nest. Along this road, worn smooth and hard by their tiny feet, a continual stream of workers passes.

Those going are unladen; those coming back bear a seed. These seeds are taken down into the nest and husked. The husks are then carried out and piled on the side of the hole opposite to that from which the prevailing winds come. These heaps of husks include those of all seeds – grass and shrub – found in the vicinity. The seeds, when extracted, are stored in an underground granary adjoining the nest.

Under certain conditions the ants can be deceived. If a long-used road is blocked and a new road drawn with some smooth hard implement, the workers, after a little hesitation, will follow the new road and it is thus possible to lead them in any direction. One species of road makers have a great aversion to crossing water; if a small trench is dug across the road at some distance from the nest and filled with water, they continue using the road, but they stop at the trench and become very excited, running backwards and forwards until eventually all the workers of the nest are collected at this spot – a confused and apparently aimless crowd. Eventually a new road is made from the point at which the obstruction occurs. This new road and the direction in which it goes is apparently determined by the direction in which most of the workers happen to run in their excitement. Several beginnings will be made by different groups thrown out from the main body. The biggest group will be the first to have a well-worn road, and this will be the one finally selected by all the workers. If the trench is dug near the end of a road immediately anterior to the place where the workers disperse to collect the seeds, and if this trench is filled with water, it often happens that a new road is not decided upon until a day has been spent in futile labour.

If a narrow bridge is placed across the water-trench directly in the middle of the old road, many, or perhaps all, workers in the collected crowd will one after another carefully test the bridge, but these attempts never go beyond an

ant's length, so that the hind legs are still on the ground while the body is on the bridge. The presence of the water in the trench is apparently the deciding factor, since they will cross a bridge with no water underneath. If a small soil-covered board is placed opposite the bridge, and ants are allowed to collect on it, it is possible to transport them across the trench in considerable numbers at a time. Now a singular thing happens. All the workers thus transported across the line of water immediately travel to the end of the road and disperse to search for seeds. They come back to the road each carrying a seed, travel to the trench, and at once cross the bridge. The operation is naturally far more risky for an ant struggling with a burden several times bigger than itself than it would be for an unladen ant. One can continue carrying the ants across the trench for a great length of time. By marking individuals with red paint it can be ascertained that in the course of time the same ones are carried across repeatedly. If the waiting ants commence a new road, it is only necessary to obliterate it in order to concentrate them at the bridge again.

And after one's patience has been exhausted, their behaviour is still the same. Not one of those coming from the nest will ever cross the bridge, while those returning, encumbered with seeds, cross at once. It may be thought that holding a large seed in the mouth possibly prevents a sight of the water, and that the fearless crossing from the far side is due to this fact. But this is not the case. If the seeds are taken from the ants just before they reach the bridge, they will continue their journey and cross just as readily as their laden fellows. And an ant will continue behaving in this manner after it has been carried over the water a great many times and crossed the bridge on the homeward journey.

The instincts involved will of course at once be apparent to the student of behaviour. On the far side of the bridge a double 'pull' is exerted. There is the instinct to secure food

and in addition there is the mightier 'homing' instinct, which is sometimes stronger than the fear of death itself. But the most remarkable thing is the apparent impossibility of teaching the workers that if there is no danger in crossing the bridge with a load, there must be less danger in crossing it without one. If they could only learn that the bridge is safe to cross, it would constitute a causal memory of the simplest kind. But the ants cannot remember.

SUGGESTION OF INDIVIDUAL CAUSAL MEMORY

Game birds are protectively coloured and, as their main environmental danger comes from soaring birds-of-prey, they have developed by selection a tendency to crouch down in the grass and lie still. So strong is this instinct that when an unaccustomed danger threatens, the same method is adopted even when it increases rather than diminishes the risk. If the danger becomes too pressing, the bird will, as a last resort, try to save itself by flying or running to some new hiding-place.

For more than a hundred years game birds have been hunted with dogs and shot at as they fly, yet still they crouch and wait until man and dog get so close that their chance of escape is reduced to a minimum. The same bird may be wounded several times, but still he crouches and waits to be killed. However, a certain adaptation of behaviour to new conditions becomes apparent, even where these constitute a completely new experience. In districts where birds are regularly shot, they fly farther, faster and scatter more widely than they do in districts where they have not been hunted, or than they would do when pursued by an eagle. There is, therefore, a causal memory. The bird remembers and its behaviour is to some extent dictated by that memory; but only to a small extent. The individual causal memory is not power-

ful enough to inhibit the phyletic memory which has become so highly disadvantageous under the new conditions.

CONTROL BY INDIVIDUAL CAUSAL MEMORY

The third stage in the pathway of mental evolution is that of an animal in which the causal memory has become predominant. For this purpose I shall review our troop of wild baboons under conditions somewhat analogous to those illustrating the second type of mental behaviour.

For some five years they had had no experience of a man with a rifle. We had taught them not to fear man as such. The result was that they allowed any man with a rifle to come very close to them. During this time many babies had been born and had grown up who had perhaps never heard a gun fired, and certainly had never had the experience of having a gun fired at them. When, towards the end of our period of observation, the troop was approached by two men armed with rifles, the older individuals at once uttered first the 'warning' and then the 'alarm' loudly and insistently; thereafter they stood not upon the order of their going. The youngsters, frightened by the cries of their elders, ran to their parents and a precipitate retreat was beaten. But when they realized that the two men were the only cause of all this commotion, they began to lag behind in their frantic race uphill and eventually stopped, watching the approaching men and the fleeing adults alternately. Two shots were fired at them. One young female was killed and another wounded. And that was the last time the scalp-hunters had an opportunity of shooting them in this manner.

For a long while the troop still tolerated unarmed human beings in their vicinity, but even this stopped when they had been caught once or twice by men with concealed rifles. Here we have behaviour shaped entirely by the new memory. The

animal is burdened by no ready-made hereditary memory useful only in meeting customary events in its environment and likely to become highly disadvantageous in the presence of new and unaccustomed conditions.

If I have perhaps unduly emphasized certain aspects of these three types of behaviour, it has been done only to make more apparent an essential attribute of the two great types of mentality in nature which they serve to illustrate. It must not be thought that I am trying to prove the absence of individual causal memory in all animals outside the order of the primates. Its development, like all evolutionary processes, can be continuously traced as existing in different degrees in different species. In insects and other lowly organisms it is almost entirely absent. Here the individual in its relation to its environment is completely dominated by hereditary memories only. In the highest mammal, behaviour is, generally speaking, determined in this manner, but there is always an adumbration of the individual causal memory. However, it is only when we reach the primates that this soul of individual causal memory takes the predominant share in fashioning the behaviour of the animal in relation to its environment, and it is here that its real place in the scheme of mental evolution becomes clear.

Nor, on the other hand, is instinct – or phyletic memory – absent in the primate. Its activity is submerged by the soul of individual memory (cf. Freud's theories), and as we ascend higher in the scale to the anthropoids, the more noticeable does this submergence become. This process is correlated to definite organic modifications.

Two other facts must always be kept in view if we are to form any clear understanding of the chacma's mentality:

1. The new mentality is not in any sense an evolutionary product of instinct.

2. The new mentality does not take the place of the old –

they exist side by side. Where the new mentality has become dominant, as in the chacma, the old mentality has become functionally submerged, but it is still there. In the primate the relation of the new mentality to the old one is of reason towards instinct.

The essential difference between these two types of mind – those largely governed by individual causal memory and those by phyletic memory – has been recognized by many thinkers, and various speculative attempts have been made to ascertain their selective cause. Professor Henri Bergson, for instance, writes in *L'Evolution Créatrice*:

'From the fact that instinct is always more or less intelligent it has been concluded that instinct and intelligence are things of the same kind, and that there is only a difference of complexity or perfection between them, and above all, that one of the two is expressible in terms of the other. In reality, they accompany each other because they are complementary, and are complementary only because they are different, what is instinctive in instinct being opposite to what is intelligent in intelligence.'

I must confess that the concluding portion of this statement does not convey a very clear meaning to me. Nor can I quite agree with Professor Bergson's further assertion that these two types of mind are the outcome of two divergent pathways in evolution, and I shall attempt in the next chapter to arrive at an understanding of the probable evolutionary course of the new mind as inferred from an analysis of behaviour.

In the meantime I wish to emphasize that this speculation of Professor Bergson's seems irrefutable: One cannot speak of 'intelligence' as the evolutionary culmination of 'instinct', in the same sense as one would speak of the wing of the bird as the evolutionary outcome of the fore-arm of the reptile. It must always be remembered that we are dealing with functions and not with organs, and there can be no question that

'intelligence' is the function of a new organ – an organ quite different from that which governs instinct. In the brains of primates and non-primates the organs of instinct and intelligence function in different degrees. It would therefore be incorrect to speak of 'intelligence' as a transformation of 'instinct' as one might perhaps speak of flying in the bird as a transformation of walking in the reptile, which is an evolved general function of the same transformed organ – in the case of instinctive and intelligent mentality they are different functions of different organs.

Both types of mentality can therefore be recognized and distinguished in all the higher mammalia in different degrees, but between the highest non-primate animal and the lowest primate there is a considerable hiatus in their relative activity. The low primate compared with the high non-primate seems somewhat beyond the mere transition stage. It is the position of the climber well over the top of the hill compared with the climber still on the nearer slope. But it is quite possible that wider research may prove this hiatus to be more apparent than real. It remains now to examine more closely the outstanding attributes of these two kinds of mind.

INSTINCTIVE MENTALITY

The term 'phyletic memory', which I have selected as preferable to 'instinct', seems to imply the existence of 'consciousness' in the human sense, since consciousness is a necessary adjunct of human memory. But I have already explained that by the term 'memory' I do not wish to predicate any identity with human memory. The term was selected only in view of certain striking analogies, and consciousness does not seem to be one of these. A question which occurs sooner or later to every student of animal behaviour is: Is there any consciousness in instinctive actions?

It is of course essentially a matter of definition whether consciousness means either (a) a mental picture of the end towards which behaviour tends, or (b) a conception of cause and effect in the behaviour adopted. One would at once be inclined to say that there can be no consciousness in instinctive action.

In the first definition there can be no knowledge of an end outside individual experience. The weaver finch hatched under a canary commences, under certain conditions, to weave its beautifully patterned nest. It has never seen a completed nest. It has never gone through the difficult and complex process of tying the first straws, and yet it completes the nest in just the same way that the wild bird does. It is hardly conceivable that the bird can have any knowledge of the end towards which its labour tends. It cannot, as it works, have a mental picture of the completed work which it has never seen. But we must not forget that such a conclusion is entirely anthropomorphic. We are judging the bird's mentality by our own. We cannot know a thing we have not experienced and therefore cannot prejudge the weaver finch. This reasoning has its weakness. We cannot weave a nest we have not seen and yet the finch certainly does. In other words, if the tendency to such complex actions is hereditary, why cannot the mental picture also be hereditary?

And the matter becomes even more difficult when we consider complex instinctive actions performed by a 'conscious' being – say, by a chacma or a human being. It is difficult to imagine a human being engaging in purposive actions where the purpose is unknown to him. It seems a contradiction in terms. And yet it does occur. George McCall Theal mentions the wonderful homing instinct of the Bushmen. Young children taken by wagon great distances from their homes found their way back through pathless wildernesses. This same 'instinct' is present in most primitive peoples, and we had an opportunity here in Waterberg of examining just such a case

of 'homing' in a descendant of the so-called 'vaalpens pygmies' that at one time inhabited the Bushveld of the northern Transvaal.

A boy of about fourteen was taken a roundabout journey of approximately 280 miles by road and rail to a new home which, because of an intervening big mountain range, was, in fact, no more than 40 miles away from his starting-point. He had never been any distance away from his original home and certainly knew nothing of the surrounding country. Shortly after his arrival he set out in the night and reached his old home two days later. His spoor was followed and it was found that his route was as nearly straight a line as the nature of the country would permit. It seemed an impossible performance. Unfortunately, the intelligence of the boy was of a very low order. Careful questioning elicited no information other than the constantly repeated refrain: 'I did not know where my home was, I ran away because I wanted to go home.'

Here is another case: A baby chacma was reared for us by a lady in Waterberg, who took charge of it a few hours after birth. It was taken away from her when it was about eight months old, and transported a distance of 60 miles over two ranges of mountains through uninhabited country. During the journey it was shut up in a dark box and every means was employed to destroy its sense of direction. The little animal was passionately devoted to the human being who had taken the place of its mother. When released at its new home it showed acute distress, running about restlesssly and climbing to the tops of trees and houses, constantly calling for its human protectress. Later in the day it became quiet but deeply melancholy and refused to be comforted. It would take no food and ignored the overtures of the strange children about it, although it had never known playmates other than children. Before daybreak the next morning it had disappeared and six days later it reached its old home in the last

stages of exhaustion and hunger, but showed the wildest delight when again embraced by its human foster-mother.

In both these cases we clearly have purposive action towards an unknown purpose. At first glance it is hard to understand how a conscious human being can undertake a distinctly purposive action without a clear mental picture of the end towards which his action is directed and of each step to be taken to attain it. But it is just this 'subconscious' behaviour of conscious beings which affords us perhaps the strongest ground for inferring that there is no 'conscious' mental picture in purely instinctive action. It is quite certain that a conscious being can carry out highly complex purposive actions of which it is not conscious. There is no mental picture, no conscious reasoning, no memory involved in its performance. If such a mental process can occur in a mind ordinarily dominated by 'consciousness', then it is certainly conceivable that it may occur in the instinctive mentality.

INTELLIGENT MENTALITY

But we are on surer ground when we come to consider the question of the mental concept of cause and effect in instinctive behaviour. It is certain that in the purely instinctive mind there is no conception of the relation between cause and effect in the world of the senses. If, for instance, a purely instinctive animal is prevented from attaining the object of its actions, it will continue its futile efforts indefinitely, never realizing that success is impossible. Even if the impediment is so simple that the most elementary conception of causality would at once make clear a method of overcoming it, that method will never be adopted it if entails a deviation from the customary course of action.

This, therefore, is one tangible example of the fundamental difference between the two types of memory: in the one there

enters the element of causal comprehension, in the other it is absent.

And there is one other difference no less significant. Phyletic memories, as the name implies, are hereditary; causal memories are not. The ability to accumulate individual causal memories is of course transmitted, but the work done, the accumulated memories themselves, are never inherited by progeny from parents. The weaver finch comes into existence latently equipped with all the complex memories necessary to overcome all the usual difficulties of its natural environment. Without instruction or individual experience, it knows how to build its nest and what material to use. It knows what its natural food is, where to look for it and how to secure it. It knows what to do to find a mate, and when the eggs are laid it incubates them and feeds the young on just the right food.[2] It knows what dangers threaten its existence, and if they appear, it knows exactly what to do in order to escape them. And it does these things without ever having seen them done.

The chacma seems a poor helpless thing when compared with this perfect hereditary knowledge of the weaver finch. Often it does not inherit even the most important environmental knowledge from its ancestors. Without instruction or individual experience, it does not know what food to eat and what to avoid; it just has no idea where to look for food. It does not know where to seek a safe shelter in the night or what to do to protect itself from the weather. It does not recognize real danger, a danger that has perhaps destroyed members of its race for a thousand years. Even the sexual sense is frequently not correctly orientated hereditarily. However, evolution has more than recompensed the chacma for this loss of hereditary memories.

It has become the fashion in certain popular 'Natural

2. The finch is a seed-eater, but it feeds its young on fish or grubs exclusively.

History' books to ascribe all manner of human psychic attributes to animals. Among other marvels, the mother is described as teaching her young one necessary environmental knowledge. This is no doubt very affecting and naturally appeals to deep human sentiments. Nonetheless, I do not think that these stories, or other tales of the immediate memorizing of complex new causes and effects, give a true picture of the animal's mind. Outside the order of primates there are no such processes in nature. It is only in primate behaviour that tradition first appears as a determining element.* The young otter needs no instructions from its mother in the art of swimming and capturing fish, even if she were capable of imparting it, since it is born equipped with all the knowledge its mother possesses. It would be interesting to study this question of the inheritance of the instinctive mentality in higher mammals under experimental conditions. However, we did have an opportunity of effecting a convincing comparison between the otter and the chacma in this respect, and a record of their respective behaviour makes clear the profound difference betweeen these two animals as far as the inheriting of environmental memories is concerned.

Both baboon and otter were taken away from their mothers shortly after birth. The baboon was reared under our own supervision by a human foster-mother. The baby otter, whose captured mother died from wounds immediately after its birth, was placed among a litter of puppies and accepted by the bitch.[3] Both were carefully kept from all contact with

* Recent studies show that in many non-primates – in particular predators – such learning is necessary. Marais, however, is of course correct concerning the superior capacity of primates. – R.A.

3. It is noteworthy that the baboon showed a deep and lasting devotion to its human parent-by-adoption. Even after a separation of three years it immediately recognized her with the utmost joy and affection. The otter became quite indifferent to its foster-parent and 'relatives' the moment it could fend for itself.

their own kind and all knowledge of their natural environment.

The otter was reared thirty miles from the nearest running stream. The only water supply in the vicinity was in a deep well, and it never, at any one time, saw more water than was necessary to quench its thirst. It never saw a fish or crab and was fed exclusively on raw meat. When fully grown, it was taken for the first time to a river pool. It ran down to the water, smelled it and drank some. Then it struck the surface two or three times with its paw and immediately plunged in, diving, swimming and 'playing' just as a wild otter does. It had not been fed for some considerable time, and within half an hour it had captured a small fish and then a crab.

Our artificially reared baboon came from a district where its natural food supply would have consisted almost exclusively of insects and wild fruit. The wild baboon obtains insects by turning over all big stones in its line of march and is especially fond of the very abundant scorpions. This is a delicacy relished by wild baboons throughout South Africa and they show great ingenuity in catching them. The scorpion is rapidly beaten about with the hand until half-dazed, and is then turned on its back by a flick of the fingers and seized by the legs. In this position it cannot sting. The tail containing the sting and poison sac is carefully removed before eating. I have never seen a wild baboon stung by a scorpion during this process. Among the wild fruit commonly eaten there are several tempting-looking drupes and berries which are poisonous. Two species of fruit-bearing shrubs are remarkable because of the very close resemblance they bear to each other. These are the sandappel or the grysappel (*Parinarium capense*) and gifblaar (*Dichapetalum cymosum*). The fruits are very different in colour and size, but the plants themselves can hardly be distinguished from one another. The fruit of the gifblaar is bright red in colour and very tempting in appearance

– but the plant secretes a strictuous poison of extreme virulence and the fruit is especially rich in the deadly substance. The fruits of the two plants are far less conspicuously coloured. Both are edible and much esteemed by wild baboons and their human neighbours. I have never seen a wild baboon meddle with a poison plant or attempt to pick a poison fruit. They carefully avoid them. Quite small youngsters seem to know the danger. How the individual acquires this knowledge I am not sure, but not even in their case would I care to suggest purposive maternal tuition.

To this, its natural environment, our captive baboon was suddenly introduced for the first time when it was nearly full grown. It had been deprived of food for long enough to make it extremely hungry, but although it was in the midst of unturned stones covering innumerable insects, it had no idea of turning them over, nor could direct suggestion awake any hereditary memory. When a stone was turned exposing a number of scuttling beetles and scorpions, it leaped away in terror and for a long time it showed the greatest fear of a scorpion. After a great deal of coaxing it was at length induced to eat two from which the stings had been removed. It was then shown a third one under a stone and this time it greedily seized the insect and was promptly stung in the palm of the hand. Each kind of wild fruit it handled with the greatest caution, first smelling it repeatedly and then nibbling small bits. When it was eventually introduced to the two plants mentioned, its confidence had grown to such an extent that it plucked and ate a grysappel without hesitation. There was just a little hesitation when it reached the poison plant. It picked a fruit and at once placed the whole of it in its cheek pouch and when it was prevented from plucking another, it at once commenced chewing the one it had. It was only then that the sense of taste must have come to the rescue, as the masticated fragments were at once ejected with every sign of distaste and fear, and never after that could our chacma be

induced even to handle the leaves or fruit of the gifblaar.[4]

It becomes clear that, generally speaking, in the non-primate most memory necessary for it to exist in a certain definite environment is phyletic and can remain latent for an indefinite time until it is called into activity through some suggestion from without. In the primate, little such memory is inborn.

In recapitulating the facts briefly, we must recall:

(a) that the behaviour of all organisms is controlled by two different types of mentality;

(b) that the foundation of the newer mentality is the ability to accumulate memories with causal comprehension;

(c) that the one is not the evolutionary culmination of the other;

(d) that phyletic mentality is inhibited by individual causal mentality and becomes inactive where the latter controls behaviour;

(e) that the one is inherited as a complete mechanism for reacting to the customary environmental events;

(f) that in the other the heredity extends only to the ability to accumulate individual memories, which renders possible beneficial reaction to all environmental events, whether customary or unusual; and

(g) that both these types of mentality exist in different degrees of activity in all the higher mammalia.

The great frontier between the two types of mentality is the line which separates non-primate mammals from apes

4. All wild ruminants in the district where this plant grows avoid it instinctively, but domestic animals never learn its danger either by direct individual experience or through heredity and large numbers of cattle, sheep and goats are killed annually. Even the native cattle, which have probably had centuries of experience, eat it just as readily as the newly imported animals. Those that recover are often repeatedly poisoned by the plant and dogs are sometimes also killed through eating the ripe fruit.

and monkeys. On one side of that line behaviour is dominated by hereditary memory, and on the other by individual causal memory. The animal whose behaviour is dominated by the individual causal mentality inherits no directing memories other than those which control its behaviour during infancy. As the capacity for registering causal memories develops in the individual so does the soul of phyletic memories become submerged.

All these stages that we see in nature in different degrees in different animals are convincingly portrayed in the ontogenetic, or individual, development of the primate soul. It is known that the development, both embryonic and post-natal, of the organism is to a certain extent a recapitulation of the evolution of the species. To this general rule mental evolution affords no exception. The phyletic history of the primate soul can clearly be traced in the mental evolution of the human child. The highest primate, man, is born an instinctive animal. All its behaviour for a long period after birth is dominated by the instinctive mentality. The knowledge of its natural food supply and where to seek it is inborn. It has a knowledge and fear of falling, a phyletic memory of an arboreal past. It clings to the mother. It knows how to show distress by its cries. But it has no memory, no conception of cause and effect, no consciousness. Then, as it grows, the new mentality slowly, by infinite gradations, emerges. The earliest sign of its dawning is the dim appearance of memory, and a mother's first glad exclamation in recognition of its coming has always been, 'My baby remembers.' Its mind can register, vaguely and uncertainly at first, an individual causal memory. And it is here that the wonderful transition occurs, a transition which the phyletic evolution of the soul of the chacma exemplifies. As the new soul, the soul of individual memory slowly emerges, the instinctive soul becomes just as slowly submerged.

The one is not an outgrowth of the other. The individual

soul seems gradually to overshadow the instinctive one. For a time it is almost as though there were a struggle between the two. The control is divided. But in the end the new soul ousts the instinctive one from directing the mechanism which controls the behaviour of the individual, and assumes forever after the predominant place. Surely in this manner and in no other, the higher primate soul evolved from that shadowy beginning of individual causal memory which we first clearly see in the higher mammals.

4

THE SELECTIVE CAUSE

In the struggle for existence there must have been some strong advantage attendant upon individual causal memory to render possible its survival and triumphant evolution. At the very outset of this investigation one is, therefore, met by the questions: How did this type of mind come to be selected? What were the advantages which it conferred upon a species?

All transformations in organic matter, all modifications or organ function brought about by natural selection, are specializations. That is to say, every modification is selected to react favourably under certain definite sets of natural conditions, and the organism in which such modification has been selected is limited, as far as that modification is concerned, to the special set of natural conditions which selected it. It is under these conditions only that it confers a real benefit upon the possessor.

Some specializations may appear to be more extensive adaptations to natural conditions than others, but in any case it is only in a relative sense that a modification can be described as general. However widespread these conditions may be, the modification which embraces them is nonetheless a specialization, and the limitation of the organism to the specific environment in which these selecting conditions exist is an inevitable condition.

No specializations in nature are without an attendant number of disadvantages. Whether the specialization continues and the attendant disadvantages are eliminated by selection of course depends upon their relative values in the struggle for existence. But even the elimination of a disadvantage can only be effected by fresh specialization. There

is no such thing in nature as an organism in perfect accord with its environment. Even the highest adaptations are never ideal. In ultimate analysis, this practical truth rests upon the certainty that all the laws of the inanimate universe are inherently hostile to organic life. The struggle of life is not, as it often appears in popular conception, merely the struggle of the organism against competing fellows. From its inception, an organism struggles against opposing laws of matter which make for dissolution and the hindrance of growth. Organic evolution is at best but the line of least resistance. Selection is not so much the preservation of the fit as it is the destruction of the unfit. For the fit it is not so much a conquering invasion as a lucky escape.[1]

But it is, after all, the restriction to a definite environment which constitutes the main disadvantage which every adaptation drags after it. The more highly an organism is adapted to struggle against a certain set of natural conditions, the more effectively it is confined to the environment in which those conditions exist. That is the universal law. The higher the adaptation to one environment, the more complete is the discord under a suddenly changed one. And since the natural conditions which select modfications are very often local – especially so with the higher mammalia – the effect of such organic reactive adaptations is to impose often a local as well as an environmental limitation upon the possessors. It is, in fact, difficult to escape the conclusion that one great tendency of natural selection is to localize as well as to specialize.

It is a general law of nature that a suddenly changed environment means destruction, and it has been practically illustrated in numberless instances in this continent of rapidly changing natural conditions. Reference has already been

1. It is no doubt a conception of this truth which colours the thread of pessimism running through all recorded human thought; the conviction that, whatever the circumstances may be, the evil in existence must necessarily outweigh the good – as the sparks fly upward.

made to the inability of drought-affected otters to exist outside their natural environment even in the presence of abundant food for which they have not been specialized. But the destruction of species is due on a far greater scale to the changed conditions attending man's advent. We have watched the dwindling and extermination of one great species after another, species that perished because they could not change their environment. The vast herds of bontebok (*Damaliscus pygargus*), blesbok (*Damaliscus albifrons*), springbok (*Antidorcas marsupialis marsupialis*) and black gnu (*Connochaetes gnou*) which at one time covered the great inland plains of Africa from horizon to horizon are on the verge of extinction or have vanished because they were unable to exist in the Bushveld which lay as a harbour of refuge before them. There is the same food, the same water, the same climate, and numbers of other great species could and did take advantage of this means of escape and still live. But these unfortunates were so highly specialized for the open plains that existence in the bush was impossible for them. One little factor – the treelessness of a locality – decided their fate.

In Waterberg it is possible at present to study this singular type of development closely. Large herds of springbok have always existed on the Springbok Flats. These flats are a small island of level, open country about sixty miles long by sixty wide, in a sea of bushveld. The open country and the bushveld merge almost imperceptibly into each other. Of late years the flats have become settled by farmers and the springbok are rapidly approaching extinction. A single step divides them from safety and they cannot take it.

There is also the instance of a herd of giraffe driven by hunters into a treeless portion of the Highveld from which escape was difficult. Great herds of other big game, with which the giraffe commonly associates in the bush country, lived there. The pasturage was good (and the giraffe can feed

on grass), water was plentiful and yet within a few years the entire herd had perished.

It is sometimes a very slight and apparently insignificant morphological modification which decides the fate of an animal under a changed environment. Very often it is not even apparent, and such is certainly so with respect to the springbok mentioned.

Organic modification, however, is never as powerful in limiting an animal to a certain environment as psychic specialization. An instinct is in this respect tyrannous. Where it is a dominant factor in behaviour, an animal will overcome the fear of death itself – that strong determinant of action – rather than violate the inborn direction. In nearly all the examples of non-primate behaviour I have described, this compelling power of hereditary memory will be apparent. Nature abounds with instances. I might add to these a classic illustration, that of the Galapagos lizard (*Amblyrhynchus cristatus*) described by Darwin in his *Journal of Researches*. It is an amphibious animal and spends most of its time in the sea. It swims and dives with just the same ease and perfection that it moves on land. It feeds chiefly on seaweed and goes long distances out to sea to procure it. It can remain under water for at least an hour. Now, it happens that all its natural enemies live in the sea. On land it is quite safe from predatory foes, or rather *was* until man arrived on the scene. So a hereditary memory was therefore selected and when danger threatened the lizard had to reach the shore in order to be safe. If the animal is frightened on land, it will not enter the water but persist in trying to get inland. Even when cornered on the beach, it will allow itself to be caught and handled rather than enter the sea, and if, when caught, it is flung into the water, instead of swimming out to sea, it at once hurries back to land and climbs out on to the rocks.

But it is not necessary to multiply instances in order to make clear the power of hereditary memory. It is a thing that

can be proved experimentally by very simple means in the case of every animal whose behaviour is dominated by this type of mind.

It will be seen that from the given facts a very general rule is deducible:

Below the order of primates an animal can seldom acquire an individual causal memory of sufficient force to inhibit the action of an hereditary one. Where an instinct is replaced or modified in nature, it is done not by the acquisition of an individual causal memory but by the evolution of a fresh hereditary memory through natural selection. It is only when we reach the order of primates that we find as a general process non-hereditary causal memories immediately replacing and modifying the action of hereditary memories.

Among the mammalia the disadvantages attendant upon all specializations are therefore far more irremediable in the case of instinct than one can conceive it to be where mere morphological modification is concerned. Even in cases where instinct is strictly correlated to organic structure it seems evident that the bodily specialization never so surely confines an animal to a limited environment as the attendant instinct. The one is, in the nature of things, rarely an insurmountable obstacle; the other cannot be overcome.

If now we picture the great continent of Africa with its extreme diversity of natural conditions – its high, cold tree-less plateaux; its impenetrable tropical forests; its great river systems; its inland seas; its deserts; its rains and droughts; its sudden climatic change capable of altering the natural aspect of great tracts of country in a few years – all forming an apparently systemless chaos, and then picture its teeming masses of competing organic life, comprising more species, more numbers and of greater size than can be found on any other continent on earth, is it not at once evident how great would be the advantage if under such conditions a species could be liberated from the limiting force of hereditary mem-

ories? Would it not be conducive to preservation if under such circumstances a species could either suddenly change its habitat or meet any new natural conditions thrust upon it by means of immediate adaptation? Is it not self-evident that in a species far-wandering, whether on account of sudden natural changes, competitive pressure, or through inborn 'wanderlust', those individuals which could best and most quickly adapt themselves to the most varied conditions would be the ones most likely to survive and perpetuate the race, and that among species, one equipped for distant migrations would always have a better chance than a confined one? Are not all the elements present to bring about the natural selection of an attribute by means of which a species could thus meet and neutralize one of the most prolific causes of destruction?

This is not advanced as a demonstrable theory. It is no more than an attempt to show that it is hardly possible to imagine conditions existing anywhere in nature at any time which would not in some degree tend towards the evolution of such an attribute. If these present conditions are self-evidently likely to select it, how much more likely for instance, would not its birth and growth have been during the earlier history of the planet, during the Pleistocene period, when cataclysmic movements of its crust and great and repeated climatic changes still belonged to the usual and customary category of natural events.

What then would be the nature of the attribute which would have to be selected in order to realize this advantage? I think that I have made it clear that no mere somatic change, except in one respect, could attain it. No generalizing perfection of hand or foot, nor the attainment of the upright position, nor the transformation of any function in any single organ could render a species immune from the danger inherent in suddenly changing natural conditions. It is not conceivable that it could have been attained in any other way

than through *a modification of the brain and its functions*. In other words, the attributes selected had necessarily to be psychic.

The first step was the selection and perfecting of a mentality capable of individual causal memory. And the probable course of its evolution can be read in the stages of this mentality discernible in different existing species. From its first glimmerings in the lowliest vertebrate, through the high stage attained in the mammals, to its perfection in the primates, is reproduced the course it ran through the ancestors of the highest primates. The accumulated causal memories themselves were not hereditary. If they had been selected, it would at once have re-subjected a species to the disadvantage of limitation. The causal memories inherited by offspring would have reacted favourably only under the conditions which created them. To me this seems the only reason why accumulated causal memories were not selectively rendered hereditary just as instinctive ones were.

The next step was the obliteration of the mentality which inherits environmental memories. It will be seen later that where there is dual control – as in the lower monkeys – the analysis of behaviour invariably creates the impression of an apparent conflict, and it seems an inevitable conclusion that those individuals least burdened with phyletic memories are the ones most likely to survive. The least reflection will show that this must be so in the case of all animals in which the new mentality has taken shape as a determinant of action.

However, instead of heredity in the new environmental memory, another benefit was conferred. If the animal had had to acquire its own memories by direct individual experience only, it would have been subjected to many new disadvantages. It would individually have had to meet every environmental danger, it would have had to discover for itself every possible food supply and the best means for utilizing it, before its memory could have been of any assistance. An

average mammalian life-time would hardly have sufficed to adapt such an animal effectively to its environment. If such a species possessed no hereditary environmental memories, each individual would have had to adapt itself to existence in this laborious fashion, no matter whether the environment into which it was born was an ancient or recent one. Under such circumstances an animal with the most highly developed causal memory would hardly have had the same chance as the animal that enters upon life furnished with all the most essential environmental memories. But inherent in the new mentality is the element of tradition. It is in reality only a consequence of the normal activity of the causal memory, but it has the result of enabling an animal to reap the benefit of the accumulated memories of its ancestors without the need of direct experience. In the highest primate, articulate speech has enormously increased the scope and extended the benefit of tradition. The general effect of tradition therefore is equivalent to the general effect of hereditary memory. It is hereditary memory without the sting of limitation.

There was, of course, no sudden leap in the inception of the new mind. It was a thing of infinite gradations and stretches away through vast periods of time. The mills of God grind slowly and very uniformly. This de-specializing tendency is, in fact, as widespread as organic life itself. It is only when we reach the order of primates, however, that the new mind emerges for the first time to take a great or even a controlling share in generally determining the animal's reaction to its environment. And it is here that we encounter for the first time behaviour clearly under dual control. It is the same duality of control that we see in the human child when individual memory first becomes active. In the lower African arboreal monkeys this psychic doubling can be clearly studied in many different stages.

There are species where the individual grows up equipped

with many important hereditary environmental memories while the causal memory is also active. For instance, a considerable number of vervet monkeys (*Cercopithecus aethiops pygerythrus*), reared in captivity, grew up with fairly complete hereditary memories. They all knew their natural food, where to look for it, and how best to utilize it. They had a clear knowledge of environmental dangers. The larger African eagles – their worst natural foe – were instinctively recognized, and were guarded against in the only possible manner – that, is, by dodging under thick branches. Beasts of prey were also hereditarily recognized, but here hereditary memory was not as clearly directed as in the non-primate gregarious mammals. A donkey, for instance, when seen for the first time, caused just as much terror as a leopard. The sexual sense was invariably correctly directed by hereditary memory.

There is, in fact, not a very great difference between them and the higher gregarious mammals as far as the activity of the instinctive mentality is concerned. But the difference becomes more than conspicuous when we come to consider the degree of development attained by the causal memory. The vervet is certainly not as 'clever' as the chacma. It is slower to accumulate individual memories and its comprehension of causality in the individual memory is not as perfect as in the chacma.

If in the vervet the 'dual control' is so equally divided that it is almost impossible to say to which side the balance swings, then it is in the chacma that the process of submergence of the instinctive mentality first becomes clearly apparent. Here for the first time individual memory assumes dominant control of the mind. And there is a further singular difference between the chacma and the vervet in respect of the instinctive mentality. In the vervet there is great uniformity of instinctive behaviour; in the chacma there is great individual variation: that is to say, all the artificially reared

vervets showed the same degree of hereditary memory. In the chacma, individuals are found that are almost as completely equipped with hereditary memories as the vervet; but a large percentage lack even the most essential ones. Generally speaking, it is the 'clever' chacma that is without phyletic memories. The 'stupid' ones are sometimes highly instinctive.

5

ADDICTION AND DEPRESSION

THE habitual use of poisons for the purpose of inducing euphoria – a feeling of mental well-being and happiness – is a universal remedy for the pain of consciousness. Euphoric intoxication is of especial interest in this study because of convincing proof that there exists in the chacma a state of mind similar to that which induces the use of euphorics in man.

I do not know of any human race, savage or cultured, which has not developed, or acquired from other races, the habit of using some poison, generally of vegetable origin, for the purpose of creating euphoria. There is hardly an exception to the rule that every race has discovered in their own habitat some such poison, or a method of manufacturing one. The only exception would, of course, be the Arctic races, but even they have all at one time or another acquired intoxicants from their neighbours in both East and West. On the other hand, I do not know of any species of animal under natural conditions that has discovered or acquired a knowledge of this kind and so formed a definite new habit. The one exception in this country is the chacma.

The poisons most widely used by man are opium and alcohol, but a list to include all the vegetable substances that are so employed throughout the world would fill a respectably large volume. All of them have one property in common: the first, and chief, physiological effect is a temporary feeling of happiness which wears off as the poison is eliminated by the system. Among savage races, alcohol is used for one purpose only: to get drunk. But even among the most highly cultured European races, alcohol was, within the memory of man, used for the same purpose by all classes of the community – to get

drunk completely and unequivocally. The disrepute into which drunkenness has fallen among the higher classes in Western civilization is a thing of recent growth.

As to the *purpose* in the use of all such poisons, I do not think there can be any question. A state of mental exhilaration or happiness is sought by the individual which he does not otherwise possess. The euphoria of intoxication replaces a condition of unhappiness varying in intensity in different individuals. But it is not every case of mental suffering which seeks relief in intoxication. It still remains mainly a matter of temperament. And even in cases where the pain of consciousness is acute and the temperament favourable, there may be sufficient correctives in the environment to rival the poison as a remedy. When these exist and when, in addition, a clear perception of the danger is temperamentally possible, the powers of subjective inhibition may be strong enough to keep the temptation at bay.

It is often said that a man 'takes to drink' on account of some disadvantageous change in his condition. I think in such cases the determining factor is none the less the pain of consciousness that was present and which became dominant by the removal of what had been a continuous restraint. Men drink on happy occasions, too, because they have the assurance that in this manner all vestiges of mental gloom will be lifted and they will attain a state of pure joyousness more in accordance with the environment.

The supreme danger which lies in the use of intoxicants as a cure for mental suffering and which often renders the remedies worse than the disease is of course the morbid organic changes resulting from habitual use. Cessation of use causes what are known as symptoms of abstinence, of a severity and painfulness proportionate to the usual dose and the duration of the habit. These symptoms are always painful, and a dose of the poison invariably affords relief from their immediate effects. Long-continued habits, therefore, set up in time a

double 'pull' – the craving for the characteristic euphoria and a dread of the painful symptoms of abstinence. It is to those temperaments in which pain is a predominant element of consciousness, and in which some quality of suffering is inseparable from thought, that alcohol and all joy-creating poisons constitute the greatest threat. Under its influence the individual experiences a complete respite from intolerable suffering.

> The Mighty Mahmud, Allah-breathing Lord,
> That all the misbelieving and black Horde
> Of Fears and Sorrows that infest the Soul
> Scatters before him with his whirlwind Sword.

In such cases life becomes a continual struggle to render permanent by excessive use the very fleeting happiness these poisons bring, or even to attain a higher state of mental exaltation, an endeavour which can never be realized. There is continual alternation between the deepest gloom of abstinence and a mental state, when drunk, which through continuous use of intoxicants begins to resemble sluggish mental anaesthesia rather than positive happiness: but even this psychological narcosis is a respite and becomes to the individual preferable to the normal condition of suffering. It is in such cases that all the bonds of civilized life are eagerly snapped, where the strongest springs of human conduct – love of friends and relatives, position, honour – are restraints more powerless than plumed reeds to stop the whirlwind in its course. Everything held priceless in normal psychic life is carelessly cast into the maelstrom. The sufferer drifts into a vicious circle and, like the scorched fly, spins in vain upon the axis of his pain. The black horde that normally infests the soul is replaced by an ordered league of deadlier foes against whom the Allah-breathing Lord now in vain unsheathes his whirlwind Sword.

Proof that it is some type of mental gloom which induces the

use of euphoric poisons is further afforded by the strength and universality of these habits among peoples in whom melancholy of temperament is a definite racial characteristic. The Russian peasantry and the Chinese might be cited as outstanding examples of nationalities whose pessimism and lack of joyousness are the first traits to engage the attention of a stranger, and there are few other races upon whom habits of intoxication have gained so strong a hold.

In this country the Bushmen are the embodiment of mental misery. It is amusing to read today the observations of earlier investigators in this respect. Many of them were in doubt as to whether these people could cough or sneeze, but they seemed to be quite sure that they did not know how to laugh! (Martin Heinrich Carl Lichtenstein [1803]: *Reisen in Südlichen Africa.*) Even their pleasures are sad beyond words. Their songs are dirges, their dances funeral processions and their favourite music a monotonous wail of misery. And never was a race so quickly and effectively devastated by habits of intoxication.

They had a poison of their own – a wild hemp widely smoked by the yellow races* in South Africa. But dagga had apparently created a high degree of tolerance or was not virulent enough to suit their taste. They seized upon the white man's intoxicants, alcohol and tobacco, with avidity. Lichtenstein described their method of using tobacco in his time. They drew the smoke from a tube of antelope bone and swallowed it. It was not inhaled and exhaled from the lungs as cigarette-smokers do these days. By swallowing, the smoke

* Marais refers to the indigenous light-skinned people – the Bushmen and the Hottentots – who inhabited Southern Africa before the darker-skinned negroid tribes pressed down from the north a few centuries ago. Their origin is unknown, but seems to have no relation to Asia. Few pure Hottentots can be found in our time although through crossing with the white population they form the considerable people known as Cape Coloureds. The Bushmen survive only in remote areas of the Kalahari desert. – R.A.

was passed directly into the stomach, so that a whole pipeful was consumed without any escaping from the mouth. It quickly induced profound unconsciousness succeeded by violent sickness, during which the swallowed smoke gradually escaped, each patient (if so he can be named) being assisted in turn by the recovered members of the party.

The yellow races of the more northerly areas (Hottentots, Griquas, Korannas) have gone a step further in the use of tobacco as an intoxicant. The tolerance set up by a century of abuse has rendered all the usual applications quite ineffective and they have now acquired the habit of consuming the thick viscous oil concentrated in old tobacco pipes. The oil is placed behind the lower lip and gradually swallowed with the saliva. It seems almost incredible that sufficient tolerance could be created for the body to become proof against such doses of a poison so active and deadly.

It will readily be imagined what effect alcohol had upon a race so strongly predisposed to its use by every trait of character and every circumstance of their lives. While it was still possible for them to procure brandy from traders without any restriction, this constituted the chief, if not the only, article of commerce supplied by the whites in exchange for the products of the industry and skill of these cattle-breeders and hunters. So powerful was the craving for drink that every restraint went by the board. They bartered not only their wealth, their cattle and skins for brandy, but their means of livelihood as well. When all else had gone, ploughs, wagons, and guns were offered. In the times of desperate need, the quantity of brandy they received in exchange was of small importance, so long as it was sufficient to cause complete intoxication. As a last resort, they invariably offered their wives and children, and it is well-known that numerous Koranna 'apprentices' were so procured by brandy-traders in former days. There was the same utter want of restraint in consuming the fiery liquids they purchased so recklessly and

paid for so dearly. The visit of a trader to a *stat* was invariably followed by numerous deaths directly due to acute alcohol-poisoning.

The race has almost disappeared. As a united nation they exist no longer, and I do not think that any South African historian of the future will hesitate to ascribe this rapid decline not so much to the hostile invasions and conquests of white and black foes as to the destructive effects of alcohol.

INTOXICATION IN THE CHACMA

On the central plateau of the district of Waterberg near the source of the Palala River we came on one occasion into contact with a very large troop of baboons which we kept under observation for a considerable time. Our interest was due to the fact that we had been told that they had discovered for themselves a method of intoxication. We had previously heard numbers of stories to the same effect about other troops, so we took this opportunity, which looked promising enough, to ascertain if possible the truth of the matter. Unfortunately, the circumstances were against us and in the end we were unable to settle our doubts definitely. But the observations are worth recording.

This troop had no less than five widely separated sleeping places, they were extremely wild, and the moment our attention aroused their suspicions they trekked away into the most inaccessible parts of the Hangklip Mountains, from the precipices of which they maintained a careful watch on all our doings. Systematic observation under such circumstances was quite impossible.

On this plateau and on the surrounding mountains of this region grows a shrub-like tree belonging to the family *Cycadacoae*. It is a rare plant and seems to have a very limited habitat. The leaves are a vivid green, and the tree bears a

small plum-like fruit of a dull red colour when ripe. Among local people this fruit has the reputation of being extremely poisonous. In spite of a great scarcity of food at the time, we found no direct evidence that it was being eaten by either birds or insects. Some trees, however, had been stripped bare and it was evident that these had recently been visited by baboons and there was every reason to believe that they had plucked the fruit. We were assured that several troops of baboons in the region were in the habit of eating this fruit, even during times of plenty, and that the animals became 'drunk' after such a feast. The drunkenness manifested itself in staggering gait, inability to move quickly, and in utter carelessness of danger, all of which rendered them, at such time, an easy prey to the hunters' dogs and rifles.

We saw none of this behaviour personally, and experiments with the fruit on captive baboons had negative results. Neither long starvation nor any other enticement would induce our chacmas to eat. Both in smell and in flavour it was 'sickly' and unpleasant. The pulp of two of the ripe fruits killed a full-grown cock in about twenty minutes. About a year subsequent to our first visit, three little children in the Palala district ate some of the fruit, and the relatives sent to us for assistance. We reached the farm-house about four hours after the fruit had been eaten. Emetics and several other home remedies (mostly utterly useless if not actively harmful) had been administered. The eldest of the three children – a girl of ten – had died in convulsions about an hour after eating the fruit. It is possible that some of the innumerable remedies administered may have had a share in bringing about the fatal result. She was described as having fallen into a deep and quiet sleep just before death. The convulsions came on suddenly; none of the three children had previously shown any convulsive symptoms. Of the other two (a boy and a girl of eight), the boy had recovered. He was still sick and lethargic when we arrived, but was able to give an ac-

count of the incident. He told us that they had each eaten two of the fruits, but the result of the emetics seemed to show that this was untrue and that many more had been eaten. The second girl was comatose and all efforts to rouse her proved unavailing at first. She was insensible to pain, the face was flushed, the pulse full and slow, the breathing deep, regular and very slow. The pupils were dilated and insensitive to light. She remained unconscious for about six hours and had to be kept awake forcibly for some time after she had regained consciousness. It was about thirty hours before she had recovered sufficiently to be pronounced out of danger. There were no convulsions.

The symptoms seemed to be those of a narcotic poison. Whether there was any euphoria it was of course impossible to ascertain from the children, and it must be borne in mind that even in known euphoric poisons the pleasant feeling is generally experienced only after considerable use and after a certain degree of tolerance has been set up.

Our own troop of wild baboons very often chewed and sucked the roots of a semi-aquatic plant which was generally known as poisonous. It was frequently used in small doses by the local people as a combined emetic and purgative, and although we never heard of a case of fatal poisoning, I can well believe, judging from its effects when used as a medicine, that a large dose would cause death. I cannot believe that its habitual use would induce euphoria. Why the baboons ate it is a mystery. In taste it was extremely nasty and its immediate physiological effects were not those which one commonly associates with joy of mind and body. But I have already referred to this inexplicable habit, which the chacma has, of chewing absolutely 'inedible' plants and leaves – substances which no human being could use except as a punishment or an act of self-sacrifice. But it must be born in mind that to other races many of the delicacies we white people eat and drink are equally unpleasant and the reason why we enjoy

them is just as mysterious to them as the strange tastes of the chacma are to us.

It will be seen that I am by no means prepared to say, as a result of my own observation, that the chacma has discovered poisons which it uses for the purpose of euphoric intoxication in the same way that man does, but my knowledge of the general character of the animal and its habits in captivity and under natural conditions make me strongly inclined to believe that the statements made to us and referred to above are true. But whether or not it has acquired such habits under natural conditions, one thing is certain: *In captivity* the chacma has a powerful psychological predisposition to the use of intoxicants, and it may be argued that this predisposition is due to the same cause as in man – namely, some kind of suffering inseparable from the new mind which, like man, it has acquired in the course of its evolution.

The South African baboon in captivity is singularly like the Bushman in its predilection for tobacco and alcohol. It needs little observation to convince one that the taste for tobacco is not instinctive and hereditary. Wild baboons certainly never make use of it even where there is every opportunity for doing so. I have often seen baboons pass through tobacco fields daily to reach mealie lands and orchards, but I never saw them touch the plants, and this, I think, is the general experience of residents in Waterberg. Our own wild troop were for a long period constantly within reach of a number of tobacco plants that grew in the vicinity of our huts, but they never touched them. In captivity, on the other hand, the chacma's taste for tobacco is so common that it was almost impossible for us to determine when any particular individual had first acquired it. All captive baboons beg for tobacco and eat or chew it with all the zest of a long-established habit. One old male showed a great liking for pipe-oil similar to the craving of the Hottentots. He had taught himself to scratch the oil out of a pipe-stem with a blade of grass

which he then cleaned on to a piece of paper, rolled up and chewed.

Every observer of the South African Bushmen describes their craving for tobacco and alcohol in exactly the same terms, and all that has been said of them could, as a matter of fact, be applied word for word to the chacma. The desire for tobacco, for instance, is always spoken of as an inborn one. Of course it is not so – but, like the chacma, the individual so immediately succumbs to the appeal of this poison that it always appears to the observer as if the inclination had existed all along and was not created purely by experience With regard to alcohol, the Bushmen required some little teaching, as there was always an initial aversion to the *taste*, but it is a common saying, based on the experience of the white races in South Africa, that a Bushman, without any previous knowledge of alcohol, becomes a drunkard the moment he once clearly experiences its intoxicating effect.

As a result of a great many experiments on the chacma, the following can be stated as a general rule to which there were, in our experience, no exceptions: An adult male chacma[1] that has once taken alcohol in sufficient quantity to experience its euphoric effect ever after evinces a strong craving for it.

There is a great difference between the reaction of the chacma to alcohol and that of all other animals below the primates which we had an opportunity of studying. We tried the effects of the continued administration of alcohol on the following animals: vervet monkey (*Cercopithecus aethiops pygerythrus*), warthog (*Phacochoerus aethipicus aethiopicus*), saddle-backed and maned jackal (*Proteles cristatus*), and klipspringer (*Oreotragus saltator*). The spirit used was absolute alcohol diluted with water in such different pro-

1. As a general rule, the female is less susceptible than the male – that is to say, it takes longer experience to establish an absolute and enduring craving for alcohol.

portions as the circumstances of each individual case seemed to indicate.

The first rule which we deduced from these experiments was that it is impossible in any of these animals to create a craving or even an inclination for alcohol by its repeated administration so long as the time interval between the doses is long enough to avoid any chronic organic disturbance. It makes no difference how long the administration is continued. The animal's natural distaste for alcohol seems to increase rather than to decrease with the continuance of forced doses.

If, however, the quantity of alcohol is gradually increased and the interval between doses diminished until a marked tolerance has been set up, then, if the administration is suddenly stopped, so-called symptoms of abstinence very similar to the human symptoms under analogous circumstances may manifest themselves. There is a general systemic disturbance. The digestive process becomes abnormal and there is a rapid falling off in condition and weight. Restlessness and sleeplessness are invariable accompaniments. In some cases, tremors involving the entire nervous system are an initial symptom, and continual whimpering cries indicative of persistent pain continue, subsiding only with the organic symptoms. Now, all these symptoms of organic suffering can be arrested at any time by a dose of the poison which caused them, and it is possible in the vervets and jackals to create a memory by repeating the process. The animal can be made to remember that a dose of alcohol will end its suffering immediately. It can be made to associate, under such circumstances, the taste and smell of alcohol with the cessation of pain. Once you have created and fixed that memory, you have also created a temporary craving for alcohol which lasts as long as the symptoms do.

It will be seen that the presumption that the chacma is in some degree liable to the same quality of suffering which is

undoubtedly an attribute of human consciousness rests upon more certain grounds than the mere fact that it exhibits the same degeneration of certain mental processes that man does, processes which assume in human consciousness the appearance of being the whole and only cause of this quality of psychological suffering. That would be a very slender foundation for such a theory if it stood alone; because at the very outset one is met by the objection that it is more than possible that this appearance of cause-and-effect is entirely fallacious. In other words, that the degenerate mental processes and organic states which I have discussed are not the cause of the pain of consciousness but are far more probably, together with the latter, the effects of a common and more deeply seated mental mischief.

If the craving for alcohol in the chacma is a strong proof of this theory because it resembles in all ways the same psychological process in man, and in this respect stands unique in the animal world, then the existence in the animal of the human 'hesperian depression' would, to my mind, be an equally strong one. Here, too, one has to deal with a mental state apparently characteristic of man alone, and quite evidently an attribute of his consciousness.

HESPERIAN DEPRESSION IN MAN

Normal mental pain in man, generally speaking, is tidal in character. With sunrise or during the early morning it is at its lowest ebb, to reach its highest flow in the evening about the time of the setting sun. In great cities and in the midst of strenuous civilizations it is difficult to study the nature of this tidal swing because of the infinite influences which all tend to modify the normal manifestation, and also because of the many remedies which man, when congregated in great numbers, devises to counteract the diurnal crisis. It is just

when under more natural conditions the psychological process would assert itself, and become clearly apparent, that the lights flash out in houses and streets, that a thousand places of amusement stand out most enticingly. It is then that man, assisted by an artificial environment created, if unconsciously, nonetheless certainly to that end, can shift the centre of mental attention completely. It is not

> . . . in luxurious cities, where the noise
> Of riot ascends above their loftiest towers,
> And injury, and outrage: and when night
> Darkens the streets, then wander forth the sons
> Of Belial, flown with insolence and wine[2]

where normal Hesperian depression can best be measured and appreciated.

It is under more natural conditions, where all these artificial remedies are wanting, that this depression appears as a clearly recognizable attribute of human mentality. On the veld it is known and discussed by both Europeans and natives with the same familiarity that any other universal common mental state is recognized and discussed. It is very remarkable and interesting that the depression reaches a climax immediately after sunset and endures for a short period only. When darkness has once settled, the mental condition changes entirely. Among the natives these phases are very noticeably translated into behaviour. An air of quietness and dejection falls upon the village just about sunset. The men and women go listlessly and mournfully about such tasks as still remain to be done. The old people gather in sheltered corners or about the fireplaces, quite silent. Conversation ceases. No song is heard and no sound of musical instruments. It seems very much like the dejection of utter physical weariness.[3] The little children are by no means

2. *Paradise Lost*, I, 496–500.

3. All these signs are, of course, absent in a village where beer has been made and is being drunk.

exempt. All laughter ceases, the games come to an end and there is a general tendency to creep closer to the mothers and elders; an apparent craving for protective fondling and endearments. As the night falls, the scene changes. The fires are newly made. Conversation and laughter are heard once more. Songs and the sound of music arise and under the brightening stars the young people congregate at the dancing-place, where the last vestiges of dejection and weariness vanish.

It is interesting to note that here, too, there is a general tendency to describe the depression as the product of reason. The more uncivilized natives ascribe it to a fear of approaching darkness. It is during the dark hours, they suggest, that wizards go forth to create misery and distress; to sow disease and death among their defenceless neighbours. It is then that the spirits of the dead have the opportunity of manifestesting themselves in a manner profoundly malevolent to the living; and other evil powers of unknown origin have all to wait for the night to attain their wicked purpose. Small wonder, therefore, they say, that human beings should become thoughtful and distressed at the time of approaching night. Why the condition should change for the better when darkness has actually arrived, they are (like their more civilized neighbours) quite unable to explain, or the explanation is childishly illogical. The Boers explain the condition, as might be expected, on more abstract grounds. The coming of night suggests the approach of death; the utter futility of human life; the distressing certainty of the end of all things; and the helplessness and paltriness of man. Of all this the setting sun is a recurring emblem.

If this state of mind is not easily recognizable in the midst of great civilizations, it must not be assumed that it is absent. In some degree it is universally experienced and has been an attribute of human mentality since the beginning of history. In the sun-stories of the dawn of civilization the daily death of the great luminary appears as typifying the feeling. In

poetry and art it reappears throughout the history of human culture. No artist has fixed upon canvas the colour and light and atmosphere of this special time of day without in some degree imbuing his composition with the 'sadness that comes with the evening'. Even under the chisel of the sculptor it has found expression in every age in innumerable stones.

In religion all pronounced and common human psychological phases are represented in some form. This 'evening melancholy', which would naturally be accentuated in the religious temperament, appears magnificently in the stately formalities of both Eastern and Western Christian Churches. In all religious literature man's helplessness in the presence of an evil against which his own inward means of defence are so clearly powerless is constantly expressed:

> Abide with me; fast falls the eventide . . .

It is in poetry, song and music, however, that this psychological process has come to striking utterance. How many 'nocturnes' are there which owe their popularity chiefly to the profound melancholy which the artist was able to express in beautiful words, colours or tones, and which finds an instant echo in most human souls? Very often it is the powerful suggestion of death which is accepted and expressed as the cause:

> The curfew tolls the knell of parting day . . .

But even when it is the beauty of the evening which makes the stronger appeal, it is seldom that that beauty can be expressed without revealing its inherent melancholy. One remembers as an example of this Milton's lines from *Paradise Lost* which Newton described as unparalleled in verse:

> Now came still evening on, and twilight grey
> Had in her sober livery all things clad;
> Silence accompanied . . .

HESPERIAN DEPRESSION IN THE CHACMA

In few phases of behaviour did our troop of baboons appear to us more human-like than in the unquestionable expression of this 'evening melancholy'. They generally reached their sleeping-place some time before sunset, to spread over the banks and rocks of the gorge-stream. Groups would collect in several shady spots and one could hear the animated 'talking' of the elders above the sound of the perturbed waters. Among the younger members of the troop this was the favourite time for mating, for strutting and boastful calling, and very frequently for romping games. It was especially the hour of the little ones. The favourite playground was a shallow rock-pool with an earth-slide on one side and a huge branch-swing that must have been used by their ancestors for generations, to judge from the mirror-like polish imparted to the bark. It was during the hour before sunset that games were indulged in with the utmost joyousness. Incessantly their happy 'laughter' and shrieks of excitement and delight awoke the echoes of the great shadowy gorge, while the older fathers and mothers sat watching the activity.

With the setting of the sun and the first deepening of the shadows a singular transformation came over the entire scene. Silence fell upon them gradually. The 'talking' ceased. The little ones crept cuddlingly into the protecting arms of their mothers. The romping young folk joined different groups, generally on the higher flat rocks from which a view could be had of the western horizon. The older ones assumed attitudes of profound dejection, and for long intervals the silence would be unbroken except for the soft whimpering complaints of the little ones and the consoling gurgling of the mothers. And then from all sides would come the sound of mourning, a sound never uttered otherwise than on occasions of great sorrow – of death or parting. I do not think there is

any possibility of mistaking the state of mind which determines this behaviour – even by one not well acquainted with the character and ways of the animal. One need only compare them with a native village under the same conditions to realize beyond any shadow of doubt that you have here a representation of the same inherent pain of consciousness at the height of its diurnal rhythm. In the case of the chacma the condition also disappears with the settling darkness. When the troop finally moved on to the krans or to the entrance of the sleeping-cave, the games were resumed and sometimes on moonlight nights continued for several hours.

In the presence of these proofs, it is hardly possible to avoid the conclusion that the chacma suffers from the same attribute of pain which is such an important ingredient of human mentality, and that the condition is due to the same cause.

6

SUBMERGED INSTINCTIVE ATTRIBUTES IN MAN

IN recent years so considerable a literature has arisen about the 'Subliminal Soul' that there are few readers who will not have some idea of the present state of knowledge regarding this strange psychological process in man. In arriving at this knowledge, however, considerable allowance must be made for the mysticism which has always found a happy hunting-ground in this half-explored country where even the angels tread fearfully. True subconscious behaviour in man is really illustrated by a psychic process which has certain definite characteristics. But before considering these it would be as well to have a clear conception of the difference between normal unconscious and abnormal subconscious behaviour.

Normal unconscious behaviour is determined by a mental process which occurs as a usual and constant manifestation in nature and which is of immediate benefit to the organism. *Abnormal subconscious* behaviour is an unusual occurrence which not only is not directly beneficial, but is so often allied to pathological conditions, that, if not a disease itself, it certainly always appears suspiciously like a symptom of disease. It can occur only under conditions of the conscious mind which are not usual and which certainly are not beneficial.

The most common type of normal unconscious behaviour is exemplified in motor habit, which in man is clearly a phyletic survival of his pre-conscious period. A man learning to ride a bicycle or to do a sleight-of-hand trick or any unusual combination of muscular movement has in the beginning to direct his centrifugal impulse with continual conscious

mental effort towards the different muscular movements constituting the action. The nervous impulse wears for itself a smooth channel, just as water does through soil, and the movements gradually become quicker and more perfect. The mental effort becomes proportionately smaller until eventually the most complete muscular movements take place without any corresponding representation in consciousness. This 'learning to do a thing' is a property common to all muscular movements throughout nature. The same 'effort' is needed in minds which are not 'conscious' in the human sense. The human baby learning to bring food to its mouth or the more difficult process of bipedal walking, a bird learning to fly or an animal to run, all exhibit a similar struggle. The same difficulty is encountered in teaching an animal a trick which requires any unusual combination of muscular movements. As the movements become more perfect the 'effort' becomes less apparent and in the end disappears. Unconscious motor habit is what Henry Maudsley terms the memory of the spinal column. In man this unconscious muscular movement is subconscious only in the sense that it is not at a specific time consciously repressed; but it was at one time and so the movement can voluntarily be called back into consciousness.

Another alleged manifestation of what is often spoken of as 'subconscious' is the so-called 'repressed thought'. Those who accept Sigmund Freud's psychology as true in substance hold that there are many 'repressed thoughts' in human mentality which can, and often do, become pathologically potent. These thoughts are – to use Freud's own word – *Bewusstseinsunfähig*. The meaning one attaches to the word, 'incapable of becoming conscious', is, however, not quite borne out by his teaching. These repressed thoughts were at one time either conscious or hovering dimly on the frontier of consciousness and were then thrust into outer darkness, where, safely hidden, they work their evil spells. Such, I take

it, is the real meaning of Freud's theories. And when one comes to consider the aim of his teaching, the word *Bewusstseinsunfähig* becomes even more inappropriate. His aim is to heal, and the healing is rendered possible by the circumstance that these repressed thoughts and tendencies can undergo a rebirth in consciousness – with the obstetric assistance of the psychoanalyst – and in this reappearance, they lose their evil potency.

If therefore, this theory is true it would appear, on his own showing, that the repressed thoughts are outside consciousness in much the same sense that a forgotten word or event is outside memory. The possibility of their recall, if not voluntarily then by means of outside suggestion, always exists, just as the unconscious muscular movements can at any time be made conscious voluntarily. If these 'repressed thoughts' do exist, they cannot be classified as 'subconscious' in the sense that I understand.

True subconscious purposive behaviour in a pure form has one feature which serves at once to distinguish it from all other types of mental activity. It is this: The subconscious actions never were conscious and can never under any circumstances become conscious in a true sense. The subject may become aware of the results of his subconscious actions, and he may even – by post-hypnotic suggestion, for instance – be made aware of the subconscious actions themselves; but he becomes aware of them in just the same way that a spectator becomes aware of the actions of another person. They are not his actions. They certainly do not originate in his own normal conscious individuality. That is what I wish to be understood by subconscious purposive behaviour in its purest form.

There are intermediate types to which this description may not in strictness seem to apply, but it is nevertheless the common-sense view to regard all these occurrences as manifestations of one and the same psychosis.

In man subconscious purposive behaviour occurs:

1. *Where consciousness is apparently normal.* 'Automatic writing' is an example. Here there is an apparent doubling of direction. The conscious and subconscious actions occur simultaneously and quite independently of each other. The subject writes connectedly and at the same time carries on a conversation or works out a mathematical problem. He is unconscious of the writing.

2. *Where consciousness is a disturbed condition.* In many neuroses and in cases of brain injury, subconscious purposive behaviour sometimes takes place while the consciousness is still more or less active. But in such cases it is evident that it is not normal. In hysterical anaesthesia, for instance, a similar 'doubling' occurs as in automatic writing – a manifestation which the investigations of Alfred Binet and Pierre Janet have made generally known.

3. *Where consciousness is absent.* Subconscious behaviour in its most clearly recognized form occurs when the normal consciousness is apparently entirely obliterated. It has been observed, for instance, during profound unconsciousness, the result of traumatic or pathological lesions in the brain and during certain forms of epilepsy. It occurs during the unconsciousness of normal sleep as somnambulism, and in the somnambulic stage of hypnosis.

In the last two instances the subconscious behaviour may be said to appear as a result of disturbances of consciousness, and even in the first case, where subconscious behaviour appears in apparently normal men, the psychopathologist holds – and not without reason – that automatism never manifests itself in apparently normal men as other than a syndrome which is the accompaniment of hysteria or other conditions implying a disturbed or diseased state of consciousness. It is a rule, therefore, that subconscious behaviour is either the result of, or a symptom of, some degree of disorganization of the normal consciousness. There may be ex-

ceptions, but the rule is so general that one would be justified in regarding alleged exceptions with suspicion.

It would lead too far afield to consider all other known types of subconscious behaviour, but I do not think that the description given is inconsistent with the general view that such occurrences as the alteration of personality, insane delusions, 'possessions', and spiritual mediumship are all more or less impure incipient forms of the same psychological process. The subconscious purpose of behaviour under hypnosis agrees with other types in that it appears only during an abnormal state of consciousness.

In its activity, however, hypnotic subconscious behaviour differs considerably from that of all other types. Outside hypnosis, subconscious behaviour is generally very much like conscious behaviour. The mind that contains it reacts in the same way as the conscious mentality does and its attributes do not differ qualitatively or quantitatively from those of the conscious mind.[1] In other words, the behaviour is essentially no different from what it would have been had it been directed by the normal conscious mind.

Here the hypnotic subconscious mentality reveals an apparently supreme dissimilarity. It also uses the same senses that the conscious mind does, but it uses them in a very different manner, and in no less a degree does it differ quantitatively in several of its attributes. It is particularly in the perfection of 'hypnotic memory' and extreme sense-acuteness that the hypnotic mind is distinguished from the normal conscious mind and from other types of subconscious mentality. These wonderful attributes were mainly responsible for the creation of the wrong hypothesis and for that sense of the mysterious which overshadowed the work of the first

1. Unless, of course, it is accepted as proved that subconscious mental activity, under certain conditions, possesses the power of direct non-sensorial contacts with other minds embodied or disembodied, or as 'clairvoyant', 'clairaudient', etc.

explorers into this condition. But even today it is difficult to look with contempt on those early errors. More systematic knowledge has not rendered these attributes any the less wonderful. They still exert a powerful influence on human imagination and often thus stand as an impediment between investigation and the attainment of truth.

It must always be borne in mind that the wonder of this hypnotic sense-acuteness and memory is entirely relative to the standard by which they are judged. When judged by the normal conscious mind, they seem to lie outside the order of nature. But when it is realized that this same sense-acuteness and perfection of 'memory' – in a certain sense – constitute the ordinary psychic life of the lower animals, that even in so high a primate as the chacma the same sense-acuteness is a normal manifestation, then the marvellousness of these attributes becomes less obtrusive.

The great number and sometimes contradictory theories that have been advanced to account for the phenomena of hypnosis need not detain us. The general effect of most hypotheses, whether they be stated in terms purely psychological or purely physiological, is identical. In one particular area there is unanimity in authoritative thought, and that is that hypnosis means a *temporary suspension of the cerebral functions*. That was the view first advanced by Professor Martin Heidenhain of Breslau, and all later investigation has tended to confirm it.

Now we have seen that it appears to be a general rule that if the functions of the later-developed mental organs are destroyed or inhibited, the functions of the earlier ones can and, under certain circumstances, do become independently active. Functions which have been partially or entirely inhibited by the action of the newer organs can under such circumstances emerge and become dominant in behaviour.

And this is what happens in hypnosis. The functions of the cerebral cortex are suspended and the instinctive mentality

with some of its inhibited attributes emerges and becomes visible in behaviour.

Apart from any other proof, the occurrence of the same behaviour in some form in all organisms from the reptile to the lower primate would have led one to suspect the possibility of its occurrence in man (under favourable conditions and in a degree proportionate to the evolutional stage his newer mental organs have reached). And proofs are not wanting in hypnotic behaviour itself that the 'subliminal soul' is in reality only the 'animal soul' still present in man's mentality.

One would not expect that in man the separation of mental functions could be brought about in so complete a manner as in lower forms of evolution. In man the development of individual causal memory has reached the zenith. It is in him an evolutionary process of longer duration than in any other existing species, and the newer mental organs are, therefore, far more closely knit than in any other animal. One would expect, there, that, however complete the eclipse of the functions of the higher organs may seem during hypnosis, the subconscious behaviour would still be coloured and influenced by some of them. And that proves to be so in fact. Yet, when due allowance is made for the influence of causal memory, certain characteristic attributes of the instinctive mentality at once become clearly recognizable in hypnotic behaviour. The chief of these are:

1. Absence of consciousness.
2. Suggestibility. (No trainer of wild animals would fail to recognize this as an especial attribute of the animal mind. By taking advantage of it man bends to his will the lion and the elephant.)
3. Extreme sense-acuteness.
4. High perfection of the 'place memory'.

The first two characteristics will be self-evident to all

students of hypnotism. More detailed attention will, however, have to be devoted to the last two, the general sense-acuteness and the sense of locality, in order to make clear their link with the instinctive mind.

7

HYPNOTIC HYPERAESTHESIA

As the causal memory becomes more perfect in the primates, so the senses degenerate. The accumulation of individual memories is quite clearly of far greater value in the animal's struggle against its environment than the acutest senses could ever be. Selection would therefore tend towards the development of the new mentality rather than towards the development of the senses. Degeneration of the senses would keep pace more or less with the evolution of individual causal memory.

In the primates the senses become more perfect the lower one descends in the scale of evolution. In man sense-degeneration has reached an extreme point. Hypnosis proves, however, that this degeneration in man is not organic, or even functional in the generally accepted sense of the term. The organs are still capable of a very high degree of sensitiveness, and under hypnosis they may actually become functional. This sensitiveness must, therefore, be inhibited by the high mentality and when this mentality becomes dormant under hypnosis the inhibition is removed. In the chacma, as one would anticipate, this inhibition has not progressed very far. Its sense-acuteness comes midway between that of normal man on the one hand and of the higher mammalia on the other.

The following record of experimental comparisons between man under hypnosis and the normal chacma will prove how nearly, in respect of the senses, the human hypnotic mentality approximates to that of the normal chacma.

TACTILE SENSE

SUBJECTS:

J.B., an 18-year-old Boer girl; poorly educated but naturally bright and intelligent; neurotic temperament and heredity.

Old male chacma; age unknown; time in captivity unknown, intelligence low; hereditary environmental instincts above the average; nervous, vicious and bad-tempered.

During hypnosis the girl was blindfolded and touched on the forehead with the poles of a large steel horseshoe magnet. She was told, 'This is the north, and this is the south', as each pole touched her skin. She was thereafter, supposedly, able to distinguish the north and south poles infallibly if touched on the forehead or hands. She could name each pole without a mistake when it was dragged rapidly across the palm of her hand. When the magnet was wrapped in two folds of a thick tablecloth, she could tell the north from the south by lightly touching the extremities of the covered magnet with her finger-tips.

There was some excuse, perhaps, for the orignal hypothesis that during hypnosis the subject was sensitive to magnetism, and this conviction was strengthened by her own explanation. When the memory of her sensations was fixed by post-hypnotic suggestion, she explained that where the north pole touched her she felt a 'comb of rays' (*kam van strale*) beating into her body to the left, and to the right when the south pole touched her, and that the sensation was the same no matter where on the body she was touched. Notwithstanding this explanation, a doubt arose as to whether she actually experienced any sensation due purely to the magnetic force. This doubt was created by the fact that her sense of touch, tested in many different ways, proved acute enough to be able

to distinguish the two poles without any aid from magnetism.

She was, for instance, tested in the following manner: in her absence twenty shells of the giant African snail, practically identical in shape, size and weight, were numbered on the inside from one to twenty and placed in that order on a table. The girl, carefully blindfolded, was then brought into the room and allowed to touch the shells, closing her hand over each one in succession without lifting or moving it. She was then taken from the room and in her absence the order of the shells was arbitrarily changed. Brought back still blindfolded, she replaced the shells in their original order, without very much hesitation, and without even making a mistake.

It was then found that when a soft-iron or brass horse-shoe was used in place of the steel magnet in the first experiment and it was suggested to her that one extremity was south and the other north, she was able to distinguish them as with the steel magnet and still, post-hypnotically, described her sensations as 'comb of rays' to the right and left respectively. Further investigation brought to light that the 'comb of rays' was no more than an unintentional suggestion conveyed to her during the experiment. Before she was hypnotized someone had tried to explain magnetism to her and had used the very words 'comb of rays' to describe the parallel lines of the force.

Blindfolded, she was able to distinguish the steel magnet from its soft-iron replica when both were wrapped in several thicknesses of the same cloth by touching the two extremities with her finger-tips.

The chacma was taught to associate the presence of the steel magnet with an imitation snake of which he was afraid. Both snake and magnet were hidden in a bag of thick cloth.[1]

1. This experiment was arranged before it was discovered that magnetism had no share in the sensation experienced by the hypnotized girl.

An identical bag contained a soft-iron replica of the steel magnet and was associated with the presence of a plantain at the bottom. A bag was always so placed that in order to ascertain whether it contained the snake or the plantain the chacma had to draw it towards him and was compelled to touch through the cloth either the magnet or the soft-iron imitation. As soon as the memory was fixed in his mind, he never once made a mistake. The slightest touch was sufficient to indicate to him whether the bag contained the magnet or the replica.

TASTE

SUBJECTS:

J.B. (as above).
Male chacma about three years old, bred in captivity; artificially reared; very high intelligence.

As a baby the chacma had developed the habit of sucking its thumb. The thumb became raw and painful and all the means commonly resorted to in the case of human babies failed to cure it of the habit. Eventually the lady who had charge of it placed on the thumb a glove finger saturated in quinine. As the chacma grew up, it retained a deep and perhaps not unnatural aversion to quinine. After some preparatory instructive experiments it was found that this baboon could in darkness – to exclude the possibility of visual identification – detect by taste the presence of sulphate of quinine in a solution of one milligram in four litres of water.

Another chacma who had once accidentally eaten a poison fruit could detect by taste similarly infinitesimal quantities of the juice in water or fruit.

The hypnotized girl, without any instructive preparation, could detect the drug in the same solution as the chacma. If

there was any difference in threshold value, it seemed slightly lower in the girl than in the chacma. The weakest solution used in either case was one mg. to four litres, and the chacma appeared occasionally to be in doubt, and there was reason to believe that he sometimes had to taste the liquid two or three times before he was quite sure. The girl was never in doubt. It was only necessary for her to place a single drop on her tongue and the moment she closed her mouth she knew whether the liquid contained quinine or not.

The same chacma could in strong light detect the presence of the drug in a slightly weaker solution – equal to 1 in 800,000 of water. The hypnotized girl showed doubt and hesitation and her errors amounted to 40 per cent. When the strength of the solution was raised to 1 in 600,000 she became infallible. When normal she could detect the quinine only in a solution four times the above strength.

SIGHT

In distant vision the superiority of the chacma seemed greater still. A young captive male could at a distance of six miles, over a landscape flickering with mirage, recognize without fail among a group of people a human friend to whom he was greatly attached. At that distance in such atmospheric conditions no normal human, even with a good pair of binoculars, could distinguish human beings from cattle. Our observation of wild troops convinced me that even this perhaps does not represent the limit of chacma vision. Among hunters the chacma has the reputation of being the most far-sighted of wild animals living in Africa.

The hypnotized girl even at half that distance failed to recognize an acquaintance, and approached infallibility only with a good pair of binoculars, though this would, in her normal state, have been impossible.

SMELL

SUBJECTS:

M.B., a 21-year-old Boer girl; fairly well educated; sister to J.B. (above); neurotic.

Several male and female chacmas.

Twenty different people, the majority unknown to the girl, each handled a different small object and then placed it in a receptacle. The girl, blindfolded, took out one object after another and by smelling the object and the hands of the different people handed each object back to the person who had handled it first without a mistake. By smell she could identify any number of acquaintances sitting in a room, walking past each one at a distance of one yard and sniffing the air. Still blindfolded, she could find a grain of musk hidden anywhere in a room. When a small fragment of asafoetida tied to a thread was dragged over a table in an irregular course, half an hour later she could trace out its path by holding her blindfolded face a few inches from the surface of the table.

Investigations with a number of chacmas made it apparent that although their sense of smell is far inferior to that of many species of mammalia, and considerably below that of the hypnotized girl, it is, nevertheless, greatly superior to that of the average normal human being. A blindfolded chacma could not recognize an acquaintance standing within a yard. But when the baboon could touch the person, it invariably made use of the sense of smell to aid it in determining identity. Its nose would be thrust up against the clothes of the person examined and it often seemed as if there was considerable hesitation and doubt. A full-grown male was unable to trace the course of as strongly scented a fruit as a pineapple after it had been dragged along the ground, and was unaware

of its presence when it was hidden in a bag three yards away.

HEARING

SUBJECTS:

M.B. (as above).

Several captive chacmas.

Of a number of experiments which definitely established the superiority of hearing in the hypnotized girl I will describe only the following: A sound of constant volume imitating the hiss of a snake, and in the case of the chacmas associated with the presence of an imitation rubber snake, could be clearly heard by the hypnotized girl at a distance of 230 yards. The distance at which average normal human beings could hear the sound lay between 20 and 30 yards. The chacmas could hear it at a distance of between 50 and 65 yards.*

The difficulty of arriving at anything like an exact comparison between the respective threshold values of these stimuli will be appreciated, but where we are dealing with values so inconceivably low when judged by a normal human standard I do not think that a very exact comparison is necessary in order to prove at least a convincing correspondence – or the reverse. And that this correspondence does exist it is hardly possible to doubt. It will be seen that in two senses, hearing and sight, there seems to be a considerable difference, but, taken generally, there is undoubtedly a closer

* It is unfortunate that Marais did not make precise comparisons in all the experiments between the same subject's sensitivity under hypnosis and in a normal state. Further experiments should be conducted. His central point of enhanced sensitivity seems, however, fairly made. – R.A.

agreement between the hypnotized human being and the chacma than between the hypnotized and normal human beings. And it seems to me a fair presumption that if hypnosis could be induced in the chacma and its behaviour in that condition controlled and directed, it would be found that its hypnotic sense-acuteness approximated that of many of the lower mammalia.

8

THE SENSE OF LOCALITY, HYPNOTIC AND NORMAL

THE sequence 'memory' of the hypnotic mentality is another outstanding feature which distinguishes it from all normal human psychic processes, and which has done much to invest the state with that glamour of mysticism which darkened the pathway of the early explorers.

It will be remembered that in the last chapter an experiment was described in which a hypnotized girl recalled the sequence of twenty practically identical shells, and that the order of the sequence was instantaneously conveyed to her through the sense of touch alone. This does not represent an ultimate feat of the hypnotic 'memory'. For longer sequences can be remembered with the same spontaneity and quickness, and there is always the same ease of 'recall'. Nor does it generally make any difference through which sense organ the stimulus is conveyed. A lengthy and arbitrary series can be registered just as effectively through hearing, sight, taste or smell as through the tactile sense.

The use of the word 'memory' must not be taken as an implication of the hypothesis that these two faculties are in any sense identical. It will be seen that, whatever else the 'sequence memory' may be, it certainly is not 'memory' as the term is understood in the human sense. Under hypnosis it is, like all other hypnotic faculties, to a certain extent influenced and coloured by the slumbering consciousness, and under these conditions there is a suggestive resemblance to normal memory. It achieves results compassed by normal memory, as wine resembles water. And there the parallelism ends. The means adopted by the hypnotic memory to attain

these results – the methods of its reaction – differ as widely from those of ordinary memory as any two other psychic processes can differ.

The comparative investigation of 'sequence memory' behaviour makes it clear that this particular hypnotic psychological process is identical with the sense of locality, and this sense of locality, in its purest manifestation in lower animals, is neither identical with the causal memory, nor even related to it. In fact, the two faculties invariably appear in the same species in an inverse ratio: the higher the causal memory, the more deficient is the sense of locality. Its highest manifestation occurs in the so-called 'homing instinct' common to most living beings, and no one who has devoted any attention to the behaviour of butterflies, for instance, will have failed to notice the perfection of the sense of locality in a mentality devoid of any trace of individual causal memory.

The nature of the sense of locality and its occurrence in higher forms will be rendered more intelligible by a systematic record of behaviour. For this purpose I shall describe the behaviour of an animal with very deficient individual causal memory (taking the chacma as a comparative standard) and compare its sense of locality with that of normal man, possessing the most perfect causal memory; and lastly I shall give an experimental record showing the operation of the sense of locality in man under hypnosis.

DEFICIENT CAUSAL MEMORY

A mare of average intelligence which we had an opportunity of observing gave birth to a foal. Two days after birth the foal was accidentally drowned. The mother was present, witnessed the drowning, the recovery of the dead body and the burying. Throughout these proceedings she showed great distress, and when the body was recovered she nuzzled it repeat-

edly, softly whinnying. After she had stood by and witnessed the burying, she commenced at once running about wildly, whinnying for the foal. She returned twice to the scene of the drowning but never to the grave. Her excited and distressed search continued for eight days. It was quite clear that only the maternal sense directed her behaviour. There was not apparent the least memory that she had seen her foal put underground.

Compare this with the behaviour of a chacma under very similar circumstances. A tame female in captivity gave birth and when the baby was a few weeks old it was severely injured in an accident. As its life was in danger it was forcibly removed from the mother, with the object of relieving its suffering and, if possible, saving its life. She showed even deeper distress at the parting than the mare had done. For three days she hardly ate at all, and kept 'calling' night and day. Whenever she caught sight of the person who had taken the baby from her, she showed intense excitement. On the third day the baby died, despite treatment. The dead body was placed on the ground before the mother. Her restless excitement at once subsided. She approached the body, making the chacma sounds of endearment, and touched it twice with her hands. She then put her face close to the back of the dead infant, touching its skin with her mouth, at the same time moving her lips in the usual chacma manner. Immediately afterwards she got up, uttered a succession of cries, walked to a corner and sat down quietly in the sun, apparently taking no more interest in the body. Half an hour later it was removed. She still showed no interest. She allowed the body to be taken up and when it was held under her very nose she showed no response. From the moment the dead body was shown to her, all her restless movements ended. She ceased 'calling', took an interest in her surroundings and again began behaving in the normal chacma manner.

It will be seen that in the behaviour of the chacma mother

there was immediate reaction to a very complex causal memory. It seems to imply a comprehension of the significance of death and its consequence. In the mare there was no apparent causal recollection of so simple a fact as the final disappearance of the foal underground.

We will now see what the sense of locality is like in a mentality so deficient in forming the simplest causal memory:

This same mare was taken through a pathless tract of bushveld a five days' journey. With her were a number of old hunters all possessing a high sense of locality, as this is reckoned among men. They steered their course by the sun chiefly. At their destination – the banks of the Limpopo – they travelled up and down the river for long distances and remained there almost two weeks. In the meantime heavy rain had fallen, destroying every vestige of spoor. They started back from a spot about twenty miles lower down the river than where they had first reached it on their northward journey. It was their intention to travel by as straight a course as possible to their original starting-point. It is a 'bad' tract of country, and to get lost in it is a matter of very little difficulty. Numbers of experienced hunters have had to bear witness to its dangers. Several have left their bones to bleach on its waterless sands. It is quite pathless, quite flat and thickly covered with bush and trees – an endless repetition of the same vistas. There are no outstanding landmarks anywhere, and one can never see farther ahead than a few yards.

The mare, carrying a pack and unattended, led the party. On the afternoon of the first day of their return journey she turned slightly out of her course and suddenly stopped. On coming up with her the men found, to their surprise, that the spot was their last camping place on the northward journey. They had been until then under the impression that they were a long distance east of their route. The mare continued unerringly and stopped at each camping-place. To the experienced hunters who followed her, as they would have followed

an infallible guide, it seemed nothing short of miraculous. If there had been any vestige of the spoor the thing was explainable, but after the heavy rains and the long time that had elapsed it is highly improbable that there was any scent, and there certainly were no tracks to guide her. But even if there had been a spoor and scent on their original route; how could one account for her reaching the last camping-place? She had steered her course to it, as with a compass, through country she had never seen before and in a direction she had certainly never travelled. And this was the same mare which could not remember that she had seen her foal put underground!

The sense of locality is therefore clearly not an attribute nor even an accompaniment of the causal memory. It is quite evidently a function of the instinctive soul, and the lower one descends in the scale of evolution, the more perfect it becomes. A bird bred and hatched in a certain locality, without any experience, travels across the world and in a year's time finds its way back infallibly to the very tree in the forest whence it started.

PERFECT CAUSAL MEMORY

It can be experimentally proved that this sense of locality is more deficient in man than in any primate, and more deficient in cultured than in primitive man. It is far less active in the lower primates than in the higher mammalia, and apparently more perfect in the birds than in the mammalia. It is, therefore, as far as man is concerned, an anciently submerged psychic attribute, and so atrophied through disuse in cultured man, so completely inhibited by conscious memory, that its very existence is hard to detect. But it is still there and can be efficiently functional under hypnosis, as the following experimental investigation will show.

A nest of a small species of Namaqua partride (*Pterocles*) was found on the Springbok Flats and its position indicated by three inconspicuous marks, all at long distances from the nest. Anyone knowing the marks, and with the assistance of a signaller, could find the nest. Without these aids it seemed humanly impossible ever to discover the nest again after one had gone any distance away from it. The country is so absolutely level that it can hardly be said to possess a watershed. It is in addition quite trackless, without a single conspicuous natural feature, and is covered with shrubs and grass all monotonously unvarying. Three eggs had been hatched just after the nest was found. The female bird was on different occasions disturbed at the nest. She invariably flew straight away at great speed until she vanished in the distance. The direction in which she flew was determined by the side on which the nest was approached. It seemed impossible that she could ever find the nest again by any of the ordinary psychic processes that a human being employs. Generally within half an hour she returned, flying swiftly and in an apparently straight line to the nest. After the duration of her absences had been ascertained, she was trapped and temporarily blinded. She was then taken a distance of three hundred paces from the nest, liberated and watched for about two hours. During this time she kept 'calling' at intervals and made three short flights, but not once in the direction of the nest. She was then caught and taken a distance of seven miles to a settlement where she could not have been before. Here her sight was restored and she was liberated. She flew straight back to the nest.

A number of different men and boys all long resident on the Flats and experienced hunters were then tested in the following manner:

Each one was taken to the nest and allowed to study the surroundings for as long and as carefully as he liked. He was then taken in a straight line away from the nest a distance of

two hundred yards and again at right angles to this line for another hundred yards. He was then told to find the nest. Out of five individuals thus tested, not one even came near the place. One, after wandering for some time – he admitted becoming gradually more confused – struck his own original spoor and so found his starting-point. But it was quite evident that not one could have found the nest by his sense of locality alone.

A boy of fourteen, born on the Flats and known to possess a high sense of locality, was then tested in the same manner. In three trials he never succeeded in getting near the correct locality. He was then hypnotized at the nest and led a long distance away while every device was adopted to obliterate his sense of direction. About a mile from the nest he was stopped and told to go back. He unhesitatingly did so in a perfectly straight line. It was ascertained that his ability to find the nest was not in any way affected by the distance he was taken away, nor by the nature of the route. Even where a series of circles were described, and numberless zigzags and angled courses, he was never in the least doubt as to the exact direction in which the nest lay. When he was led away blindfolded and the same methods of mystification were adopted, the moment his eyes were opened he invariably turned and walked in the right direction. If, however, he was led away blindfolded even a short distance and told to find the nest still blindfolded, he not only could not do it but as often as not walked directly away from it. And the same result followed if he was led away open-eyed for a short distance and then told to go back blindfolded.

It is evident, therefore, that in the hynotized boy qualitatively the same incomprehensible faculty of location became functional under hypnosis as existed in the mother bird.

Another interesting fact that became apparent was the evident influence which sight exercises on the operation of the faculty. Trained pigeons if temporarily blinded cannot

'home'. They can find their way back on fairly dark nights, but if the night is very dark they become confused and lose their sense of direction.

But the sense of locality is certainly not just a mere 'matter of seeing'. It will be remembered that in the cases mentioned the subject 'homed' in a direction which led through localities never before seen. The 'homing' pigeon does this habitually. It is usually placed in a basket and carried inside a closed vehicle for great distances and returns by a direct route. Under such conditions there can be no 'sight memory' to guide it.

An explanation that suggests itself is this: Every movement through space, every turning of the body on its axis, is registered in the 'subconscious' mentality. So that the animal at the end of the journey, even when it has been shut up in a box, bears within itself a complete psychic chart of the route traversed. But, while initially this seems the only psychological theory, there are difficulties in the way. It cannot account for homing by a route different to one traversed. In the case of the boy mentioned in Chapter 3, for instance, it is difficult to imagine how a complete psychic chart of a single line could confer all the benefits of a mathematically accurate geographic map.

Further research will, no doubt, make clear a great deal that at present seems inexplicable in the sense of locality. In the present state of knowledge – if one is searching for marvels – it must always seem that this faculty of the instinctive soul is just as wonderful as any of the alleged exploits of telepathy and clairvoyance. An animal possessing it must indeed be both clairvoyant and telepathic. Compared with normal human mental powers, it seems to border on the miraculous. It is equivalent to the attainment of knowledge through no known sense-organ. Its manifestations seem to justify the conclusion that there must exist a method of communication between mind and the external world other than

through the only channels recognized by normal men.

To recapitulate briefly: The sense of locality in its most perfect form is invariably associated with the mentality in which the individual causal memory is least developed. The mare could not remember the simplest cause and effect and yet could steer her course unerringly through quite unknown country, and man, an animal possessing the highest causal memory, was not only unable to imitate this achievement but failed to understand the psychic process involved. And an investigation of the phenomena of hypnotism justifies the conclusion that the hypnotic memory is no other than the phyletic sense of locality particularly and temporarily liberated from the inhibitary control of the functions associated with the cerebral cortex. This inhibition of instinctive faculties, which we have already considered in the chacma, is therefore apparently a process inevitably associated with the development of the new mentality, and an examination of its occurrence in man renders more intelligible the nature of its beginnings in the lower primates.

9

SPECIFIC CONSEQUENCES OF THE EVOLUTION OF PRIMATE MENTALITY

THIS somewhat lengthy digression will have made it clear that the evolution of the mind of individual memory and the consequent submergence of the mind of hereditary memory is a process discernible in the highest primate, man, as well as in that comparatively lower primate, the chacma. The vast and fundamental difference which exists between the old mind and the new in its method of reaction to the environment has had, as may be imagined, certain far-reaching consequences; and the chacma, whose behaviour is directed chiefly by the new mentality, seems to exhibit these consequences in no uncertain manner. Some consideration of these effects is necessary.

The evolution of instinctive mentality is always in the direction of more complete specialization. The higher and more complex an hereditary instinct is, the more efficiently does it react under certain definite natural conditions – namely, the conditions that selected it – and the less able it is to direct behaviour beneficially under changed conditions or new ones. Whenever an animal adapts itself suddenly to changed conditions, it will be found that this is not a reaction of the phyletic memory, but is invariably due to its inhibition, partial or complete, by the acquisition of individual causal memory. The animal adapts itself not by means of the instinct but in spite of it.

Heredity of behaviour is one of the distinguishing marks of the phyletic mind. An instinct is sometimes so complex and its beneficial reaction dependent upon such a long chain of causes and effects that the essential difference between

'instinct' and 'intelligence' is easily missed. Many careful and distinguished observers have regarded these complex instincts as a complete vindication of the contention that such behaviour is directed by 'intelligence'. If the memory which directs behaviour is hereditary, it is quite certainly instinctive. An individually acquired environmental causal memory is never transmitted from parents to offspring. And because an instinct is in itself unchangeable, except through the long and dangerously destructive process of natural selection, its possession always entails a disadvantageous limitation of the existence-scope of the organism whose behaviour it controls. It is here that the evolution of the new mind becomes apparent, working towards the breaking down of disadvantageous limitation. It is the great psychic generalizing process of natural selection.

By the acquisition of individual memories an organism is to a proportionate extent freed from the stringent necessity of limiting its activities to a defined environment. But even with this new weapon in its armoury the struggle of a species against nature is still hampered by the existence of hereditary behaviour. Its tendency is always to neutralize the beneficial action of individual memory. Selection therefore gradually renders inoperative the mind which determines hereditary behaviour. As one ascends in the evolutionary scale through the primates, the mind of hereditary memory becomes more and more inactive. Most of its attributes, although still in existence as the functions of existing brain centres, are inhibited by the new mentality from taking any share in the direction of behaviour. Some of these instinctive attributes which are still beneficial, and therefore necessary, seem to be controlled by the new mind. Their reaction can in different degrees be either inhibited or called into action voluntarily. This is so, as will be seen, in the higher primates even in the case of so universal and essential an instinct as the sexual sense. Under such conditions an instinct, even when

operative, loses its stereotyped character, that fixed and changeless response to outward stimulation which is the outstanding characteristic of activity in the purely instinctive soul.

The power which causal memory confers of immediate adaptation to changed environmental conditions affords a species an enhanced protection against the hostility of nature generally, and this has a remarkable result. The elements in nature hostile to organic life – and that seems to be all nature – constitute the means by which natural selection operates. Natural selection is in effect the elimination of the not sufficiently specialized. When, therefore, an organism is protected against this active hostility, it is to the same extent protected against natural selection. It is something in the nature of a vicious circle: natural selection in the end destroying itself.

It will be seen presently that this protection can hardly be regarded, from the point of view of well-being of the species, as a beneficial process. Our present knowledge of nature precludes the concept of any other force which could make for the endurance of organic beings, and we are, therefore, apparently face to face with the inevitable conclusion that a condition disadvantageous to a species has been attained by natural selection. At first glance it seems a contradiction in terms. The very fundamental conception of selection is the retention of beneficial attributes only. A disadvantageous condition cannot be brought about by natural selection.

This apparent paradox is not a real one. It is based on a confusion of ideas, and practical experience of nature soon teaches one to distinguish between a primary benefit and a secondary accidental disadvantage resulting from it. As long as the accidental disadvantage does not completely outweigh the main advantage, it will continue as a satellite attendant upon its primary. Such an accidental disadvantageous result is the protection from natural selection in the chacma. The primary advantage clearly was the removal of environmental

limitation, and this removal was brought about by a process destructive of natural selection itself.

The difficulty of understanding such a simple and universal law is increased when the mind is influenced by that trend of abstract speculation which is apt to regard evolution by means of natural selection as some infallible process tending towards some ideal state of perfection. A direct and practical knowledge of nature soon corrects this wrong idea and renders comprehensible how such an apparently disadvantageous condition as protection from selection could have been brought about in a species. It becomes at once evident that in the whole scheme of organic evolution no 'perfection' has ever been attained and that in the nature of things it is unattainable. The end of natural selection is specialization, and every specialization is at once followed by a number of disadvantages which may increase in valency in proportion to the progress of the specialization until they neutralize entirely the benefit which it originally conferred. The specialization then becomes selectively modified and this modification means only specialization in a new direction. The process, therefore, is an unending one, and the attainment of perfection – that is, an organism in perfect accord with its environment – is a practical impossibility. Natural selection regularly brings about accidental and often disadvantageous consequences, and the reduction of the power of natural selection by the acquisition of non-hereditary environmental memories is an example.

This enlargement from the confining tendencies of the instinctive mind was the immediate benefit conferred upon the chacma by the attainment of a dominant individual causal memory. We have seen how it has enabled the species to penetrate the most varied natural environments. They have indeed become citizens of a large world. For them restriction to a locality no longer exists. For them there is no

longer a supreme danger in the invasion of threatening competition or any sudden or radical change in natural conditions. A door of escape is always open to them. They can either adapt themselves instantly to the new conditions or migrate, even where such migration entails a new environment.

The psychic power of immediate adaptation, by the acquisition of and reaction to individual causal memories, culminates in man, the highest primate. His exalted development of the new mentality has rendered the species heir to all the earth and the fullness thereof. Against his invasion neither the sub-tropical deserts nor the polar ice has been proof. But if this was the benefit which causal memory conferred upon the chacma, then the indirect accidental result of that evolutionary process – namely, the protection against stringent natural selection – has had results in other directions which, one is inclined to believe, must eventually have a profound effect upon the fate of any species.

Whenever a species is protected from the severity of natural selection, certain definite results ensue, and these are always proportionate to the extent and duration of the protection. These changes are included under the general and somewhat unmeaningful term 'degeneration', and they are, of course, especially noticeable in man and in domestic animals, where natural selection is at its lowest ebb.

When these changes are compared, it is found that two of them seem to assume prime importance. These are (1) divergence from specific type, and (2) disturbances of the sexual sense.

On examination, it appears that the real cause of their apparent importance is due to two factors: They represent the sum of a great number of changes which affect every organ and the function of every organ; and the fate of the species seems to be so deeply involved in them. It is to these two changes, as they relate to the chacma, that the next two chapters will be devoted.

10

DIVERGENCE FROM TYPE

TYPE may be defined as the mean of the hereditary beneficial attributes established by natural selection in a species. Variation from type is a thing of constant and regular occurrence. Nature, in the popular saying, never produces two things exactly alike. It will be found, however, that variation in any species, if it can be measured at all, generally exhibits a regular curve. The Dutch botanist Hugo de Vries found, for instance, in measuring the length of a number of seed-pods, that the majority of pods fell under the numbers nearest the mean. The absolute mean contained the greatest number and as the extremes were approached they became regularly less – on the one side the long ones and on the other the short. And this law holds good throughout nature. It is, in fact, no more than a mathematical demonstration of the concrete truth upon which rests our abstract conception of type.

Theoretically, one would assume that the tendency of natural selection would be continually to eliminate the more extreme variants. Individuals possessing in the most perfect form the selected characteristics would be the ones most likely to survive, and these would be typical individuals. This theoretical interpretation of the method of selection has also been empirically verified. The American naturalist Hermon Carey Bumpus found, on measuring birds of one species that had been injured during a storm, that the individuals that perished were the extreme variants. Those that recovered were the individuals nearest the mean. Weldon and Tower found that the same thing occurred in beetles and terrestrial molluscs. Nor could it well be otherwise. If the deathrate was not highest among the variants, the theory of natural selection could not stand.

It is, of course, conceivable that variations may sometimes under favourable conditions, prove more beneficial than the typical attributes, and it is possible that such discontinuous variations or mutations may, as Professor Hugo de Vries assumes, occur at long intervals, and that these may be the origin of distinct varieties and species. Whether this be so or not, it seems certain that favourable variations are the exception in nature. The general rule is that divergence from type is the mark of the unfit. In this country instances of extreme variation among the larger mammalia occur very rarely, but they are not unknown. In such cases, it would seem, sexual selection tends to become the dominant factor in the elimination. Albinism is an instance of such extreme variation. Several naturalists have noted that albino birds, kept under observation, did not succeed in finding mates, and we have trustworthy records of the same thing being observed among the larger African mammalia. Thus an albino springbok (*Antidorcas marsupialis marsupialis*) was solitary. Whenever she came in contact with a troop of her own kind, she was mercilessly attacked by male and female alike. A white klipspringer (*Oreotragus saltator*) was also so continually persecuted by other klipspringers that it took shelter near a homestead and became quite tame. It was never seen with a mate. A black wildebeest (*Connochaetes gnou*) with a white blaze[1] was also thrust out of the herd, which it always followed at a safe distance. A fur-horned kudu (*Strepciceros strepciceros strepciceros*) was solitary, but this may have been due to the continual pursuit of hunters who were anxious to secure so unusual a trophy. It would thus seem as if natural selection had two strings to her bow in the maintenance of type: A greater incidence of mortality among ordinary variants is the general method, and with extra forms there is usually protective sexual exclusion.

What would be the effect on the type of a species if it was

1. A not uncommon variant. It is beyond doubt a reversion.

partially protected from natural selection? It is self-evident that in such circumstances any variant, whether it was a progressive modification or a reversion to ancient type, would have a chance of existence more nearly equal to that of the typical individual than it would under conditions of severe selection. The atavistic revenant and the progressive variant would be protected against the hostile conditions that would otherwise make their destruction certain. The variation curve would become irregular. It would no longer be the same as under the more usual natural conditions. The members of the species falling within the absolute mean would become relatively less and a portion of the individuals that would fall under the average in a species subject to selection would now have a tendency to be distributed progressively towards the ends of the curve. Under protection, therefore, variation would tend to have an increasing influence on type.

That this is so among such highly protected species as the domestic animals is quite evident. If we take one of the latest additions to the category, the African guinea-fowl, where a comparatively short period in protection has created the common domestic tendency towards albinism, it will be found that there is no selective tendency adverse to the patchy individuals other than that brought about by man's intervention. It is interesting to note the effect of variation on hereditary type in this species. If a number of domestic birds are allowed to mix with wild birds under natural conditions, white marks and patches will appear for perhaps three or four generations. Then they entirely disappear.[2] If, on the other hand, they are mixed with wild birds in captivity, or recently tamed ones, the hereditary effects on type are far more lasting. I know of cases where a very slight admixture of domestic blood has caused the persistence of white patches

2. Crossing under natural conditions is unsuccessful if care is not taken to exclude extreme variants. Extreme forms have a tendency to separate from the wild birds.

for twenty years after its introduction. It is hardly possible to doubt that in the wild flock the variation is eliminated by natural selection, and that it continues in the protected flock because of the weakening of selection.

One would anticipate that the chacma, just to the extent that it is protected by its 'intelligence' from the more rigorous natural selection, would show a tendency towards the same variation that is conspicuous in man and the domestic animals. And such anticipation would be verified by a very little observation.

When we commenced our investigation we had not such anticipation, and yet one of the first impressions we gathered was that there was something very much wrong with the type of the chacma. It was possible in a comparatively short time to learn to know and to recognize individuals in a large troop, and this was contrary to all our experience with gregarious mammals outside the order of the primates. It took perhaps a little more time and a little closer study than would be necessary to know and to distinguish the same number of individuals among an unfamiliar human race, but I do not think that the closest study or unlimited time would enable one to attain a like result with the same number of springboks, for instance. The first explanation that suggested itself was this: that, since the chacma, after all, more closely resembles the human being than any non-primate mammal, an eye trained to know and to recognize human individuals would discriminate more easily in this closely related species than in a more distant one. But more exact methods of observation soon convinced us that the ultimate reason lay in this and in nothing else: that there was a greater and more extreme individual divergence from type in the chacma than in any 'natural' non-primate species known to us.

There was a greater difficulty when one approached the question of definition. What exactly was this variation? It was at once apparent that certain conspicuous modifications

had a tendency to recur constantly, and it was perhaps possible to ascertain the extent and the percentage of their occurrence. But these outstanding 'single' modifications did not lie at the root of the matter. It was rather the sum of an infinite number of small variations in each individual that rendered recognition easy. We ascertained the existence of certain distinct correlations, such as, for instance, the shape and size of the occipital ridge to the relative length of arm, and exhaustive research would no doubt prove that such correlations of growth are attendant upon every somatic modification, great or small. But generally our own attempts at systematizing yielded negative results, and gradually the conviction was forced on us that variation in the chacma is so irregular as to defy definition and to baffle all effort at classification.

I think just the same difficulty would be experienced, to an enhanced degree, in attempting to classify or define divergence from type in man. It is possible that all these variations may occur in accordance with the Mendelian laws of heredity, but even this we were unable to ascertain either experimentally or by observation under natural conditions. Though one thing seems certain: this variation is of the same nature as that occurring in man and the domestic animals. These species are, of course, far more completely protected from natural selection than the chacma, and the tendency in them is therefore far more advanced. In man, the most highly protected of mammals, individual divergence from type has reached an extreme point. No single organ or function of his body is exempt; even the vital organs show a degree of variation for which identical conditions in nature will be sought in vain.

It seems, therefore, a safe assumption that the tendency to vary in the primates must be progressive, and that the rate of progress is determined by mental development, even if most of the modifications are in the nature of acquired characteristics created by the environment only, and are therefore

not transmissible. Some in each generation would be hereditary and must have an increasingly adverse influence on the maintenance of type. Psychologically, the same extraordinary divergence is apparent in the chacma. Reference has been made to the difference between the vervet monkey and the chacma as far as hereditary individual memory is concerned, and the fact was noted that in the chacma there was considerable variation in the inheritance of phyletic memory, which in the lower species was quite uniform.

This psychological variation, like somatic divergence, seems to be reducible to a more or less regular curve. At the one extremity come the individuals with highly developed phyletic knowledge and proportionately undeveloped 'reasoning' powers. Their mind is instinctive, their reasoning 'animal-like'. The casual observer would describe them as 'stupid'. In the middle comes the common type in which the two souls are equally developed. These individuals inherit a certain amount of hereditary memory – less than the lower type does, but still certainly directive – and their individual causal memory is also 'average'. At the other extreme come the highly intelligent animals – the clever ones – who are nearly devoid of hereditary memory. And between these three types come the usual gradations.

One would, on anthropomorphic grounds, be inclined to assume that the highly intelligent type of mentality would be the one most likely to be beneficial to the species in the struggle to live, and that this must therefore be the one towards which natural selection tends. It would appear, however, that as far as the chacma is concerned, both the 'animal' soul on the one hand and the more human-like soul on the other are, under existing conditions, in the nature of less advantageous variants. The mentality combining both types more or less equally is clearly the one which has thus far proved most beneficial to the species. But it is quite conceivable that environmental conditions might arise under

which the higher mentality would be selected and a new variety or species thus created. That is a conception more in accord with our present knowledge of evolution than the popular erroneous conclusion that natural selection must necessarily be working towards the establishment of 'human' mentality in all primates. There would be just as much reason for assuming that the long-necked okapi (*Okapi johnstoni*) must necessarily in time become a giraffe.

One can hardly fail to notice the analogy which exists between the psychological variation curve of the chacma and that of man. Human mental variation has at the one extreme congenital idiocy and all the grades of 'weak-mindedness' up to the average intelligence. On the other side come the mental 'prodigies' the artists, the poets, the geniuses and, finally, the insane. These extreme variants seem to be representative of the same phyletic types of mentality that are conspicuous in the chacma.

It would seem that in the chacma mental variation is very closely correlated to the general shape of the skull. The two extreme cranial types are, at one end of the scale, the pronounced cynocephalic form with excessive orbital ridges, a greatly developed occipital ridge and an extreme orbital structure,[3] and at the other the 'round-headed' type in which these characteristics are much less developed and the general shape of the skull tends towards that of the anthropoid. Needless to say, the more human-like mentality is invariably associated with the more anthropoidal cranium, and the animal-like with the cynocephalic.

It is interesting to note that this cranial variation of the chacma is 'recapitulated' in ontogenetic development, and from the nature of the development of the individual one would infer that the chacma is descended from an ancestral

3. The 'gorilla' ridge and the orbital ridges are of course invariably correlated, as one would anticipate from their structural connection.

form which far more closely resembled the existing anthropoids and which may have possessed a higher mentality than the existing type. The chacma foetus and a newborn baby are far more chimpanzee-like than the adult is. Indeed, at certain stages of development the foetus resembles the adult chimpanzee more closely than the adult chacma. Even the first hair is quite black and resembles that of the chimpanzee in growth and texture. If a series of skulls, from foetal to full maturity, are compared it will be seen at once how the cynocephalic characteristics increase with age, and what a great difference there is in this respect between the foetal skull and that of the adult.[4]*

It is, I think, the persistence of the anthropomorphic type of skull during youth which has given rise to the popular idea in South Africa that there are two species of baboons – long-faced and short-faced – and that the short-faced are always 'cleverer'. The 'short-faced' variation certainly does occur in adult forms, and, as I have suggested, it is associated with a higher type of mentality, but it does not occur to such

4. The individual development of the chimpanzee is analogous. The foetus is much more human-like than the adult. Here there is reason for believing that this anthropoid also represents a 'degenerate' type – that is to say, it is descended from ancestors which were more human-like than the adult chimpanzees. As in the chacma, the resemblance persists in the early post-natal stage of development, when it is also very noticeable in behaviour. The chimpanzee baby cries so like a human baby that the sounds are easily mistakable. It 'pulls faces' in the same way and similarly jerks its arms and legs spasmodically. At a little later stage of development it shows acute distress by the human method of throwing itself on the ground, aimlessly kicking with its legs and moving its arms about. The eyes are tight shut, the face is distorted and its wailing cries are very like those of a human child at a lower stage of individual development.

* Contemporary theories of the Dutch ethologist Adriaan Kortlandt (though not as yet widely accepted) suggest, as did Marais, that the ancestor of the chimpanzee was more human-like than is the chimpanzee itself. – R.A.

an extent in mature individuals that it could have suggested the idea of two distinct varieties. I think the only explanation is that young ones are mistaken for individuals of a distinct variety and the occurrence of an occasional adult 'short-face' serves to strengthen the impression. There are better grounds for believing that occasionally either the 'long-faced' or 'short-faced' variation has shown a tendency to become predominant in certain isolated troops; our own observation, however, afforded no evidence at first hand of the existence of such a tendency and I think second-hand evidence in its favour should not be accepted without reserve.

On even more dependable evidence rests the assertion that many years ago in an isolated troop in Rooiberg the tendency to albinism appeared as a hereditary characteristic. We saw a white female that was said to have been captured from this troop as a baby. A trustworthy informant, a Wesleyan missionary who had been stationed for many years in this country, informed us that at one time he estimated that ten per cent of the individuals in the troop showed white bands and patches. Pure white ones were rare. If the characteristics were really hereditary and not due to the conditions of the environment or to something in the nature of an infectious disease, the circumstance would be extremely interesting, pointing to the origin of a genuine mutation. What makes it doubtful is the fact that although true albinism is quite common among natives, its heredity in the human being is highly questionable.

One would anticipate that the anthropoids, possessing as they do a far higher protective mentality, would exhibit generally greater individual divergence from type than the chacma; and our present somewhat scanty knowledge of the great man-like apes seems to confirm this assumption.* My own knowledge of the chacma leads me to believe that some

* We must again recall that in Marais's time no other study of wild apes or monkeys had yet been made. – R.A.

of the different forms of the chimpanzee which have in recent years been discovered in this country and which have been assigned to distinct varieties will eventually be found to be continuous variants of the same species. Even now it is becoming difficult to draw a hard-and-fast line between two such widely different forms as the gorilla and the chimpanzee. Several specimens of gorilla-like chimpanzees and chimpanzee-like gorillas have been secured which point to the probability that those two forms are connected by an unbroken chain of intermediate types. It is possible, as I have pointed out in the case of the chacma, that there may be a strong tendency in the higher primates for certain variations to become predominant in isolated groups. That is certainly so in man. It is impossible to imagine how else the different races of human beings could have originated. Now I am inclined to think that an analogous thing has happened or is happening both with the African anthropoids and with the orang-utang – that variations which were 'continuous' are apt to become predominant in groups through isolation and that to this process in nature are to be ascribed the different local 'races' of the big apes.

It is hardly necessary to point out that, if this proved to be true, there is no similar persistent process discernible anywhere in nature in species subject to rigorous natural selection. Among lower animals, where a distinct variety has been established by natural selection, it is generally kept within its distinct limits by those insurmountable barriers of sexual selection and the sterility of hybrid offspring. I am strongly inclined to think that the offspring of no two sub-races of the same anthropoid will be found to be sterile.[5]

5. In the African anthropoid, as I have suggested, it is even now difficult to draw hard-and-fast classifying lines. I had an opportunity of examining a female called Johanna, whose extraordinary intelligence surprised even those well acquainted with the mentality of the big apes. She was described as a gorilla, but she certainly had more

As far as the chacma is concerned, however, there are none of the elements of uncertainty which render the formulation of all such hypotheses with reference to the anthropoids merely tentative suggestions. Our knowledge of this species is wider and more definite, and it can therefore be stated without reservation (*a*) that there is greater individual divergence from specific type than in any other non-primate mammal in this country, and (*b*) that the only possible cause of this divergence is the same as that which creates a similar tendency in the domestic animals and man – namely, the ebbing force of natural selection.

It must not be thought that this variability due to protection is confined to the primates and domestic animals. It is a universal law of nature (and its methods of operation have been indicated in this chapter) that variability increases as the struggle for existence becomes less severe. Under natural conditions there is perhaps no better instance of protection from selection than that afforded by oceanic islands. The isolation and consequent want of immigratory competition, the absence of natural enemies, an equable climate and a plentiful food supply constitute for many species a highly protective environment in such islands. And the result is always the same: extreme variability. And if these varieties are localized, they are often in surprisingly small contiguous and confined groups.

Most naturalists who have examined the living forms in such islands have been struck by these circumstances. In the Sandwich Islands, for instance, there are over three hundred recorded species of the land mollusc *Achatinella*. Every valley has a localized peculiar variety. So too in the Celebes – Fritz Sarasin has described the astonishing variation of the same

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chimpanzee than gorilla characteristics. These were, however, so evenly divided that it was impossible on a superficial examination to say on which side the balance lay.

genus, united by an unbroken chain of intermediate forms; and the same thing occurs in higher forms in a great many remote islands. But although this fact has been observed frequently, the natural law of which it is the result has never been clearly recognized and defined as far as I know – the law that protection from rigorous selection means a smaller death-rate among the variants of a species.

11

DISTURBANCES OF THE SEXUAL SENSE

WE termed an abnormal manifestation of the sexual sense in the chacma any behaviour which had as its ultimate purpose sexual satisfaction, but which deviated widely from the order found throughout nature and was clearly not beneficial – in that it was not directed to the preservation of the species. This seemed a common-sense definition, and the use of the word 'abnormal' is justified since, employed in this manner, it will always convey a definite meaning.

It is possible to classify these abnormal manifestations into two main groups:

1. Where the end itself is 'unnatural'; that is, sexual behaviour which aims at satisfaction of the sexual sense but which cannot result in reproduction.
2. Sexual activity which may result in reproduction but where the behaviour involved differs widely from what is normal in the mammalian family.

Both types of abnormality are variations from type, and in both the crucial test is the absence of any benefit from the evolutionary point of view.

It will be recognized that these abnormal manifestations are the invariable accompaniment of protection from selection, just as somatic variations are. They occur in different degrees in domestic animals and man, and their common characteristic is always some form of deterioration. There is a loss either of the definite purpose of sexual activity, or of a clear direction as to its attainment. And in both instances the loss is disadvantageous since reproduction, the reason for all activity of the sexual sense in nature, is always adversely affected. It does not seem an irrational assumption that this

process, if progressive in a species, must end in sterility, since individuals exhibiting extreme forms of these variations are certainly sterile. These sexual abnormalities must therefore be regarded as continuous psychological variations correlated to, and due to the same causes as, the physical variability described in Chapter 10.

Although I propose to deal chiefly with more or less extreme variations, the average expression of the sexual sense in the chacma – what would ordinarily be called the 'normal' – will also have to be treated in order to make clear the degree and nature of each variation. Now, this usual or average sexual behaviour is in itself in many respects quite abnormal – almost as abnormal as it is in man. In certain fundamental characteristics, sexual behaviour is uniform throughout nature, and it is in just these characteristics that primate behaviour often deviates widely. The nature and extent of these deviations in the chacma will become clear from the following description:

GENERAL SEXUAL BEHAVIOUR

The predominant place which the sexual sense assumes in the life of the chacma is remarkable. There is nothing among the gregarious mammalia resembling it. 'Lascivious as a baboon' is a popular saying in this country, and although the accuser does not come into court with overclean hands, the implied charge is certainly not baseless.

The limitation of season, the determining condition of a natural outward stimulus, the exclusion of the extremely old, and the entire absence of the sexual sense prior to the maturing of the sexual organs, limit the actual activity of the sexual sense in gregarious mammals to a relatively small fraction of their lives. For the chacma these restraints no longer exist.

The common order in nature is that the operation of the sexual sense, in both male and female, is in the nature of a pure reflex. Among most gregarious mammalia, certain physiological changes take place in the female once annually and serve to excite her sexual sense. These changes in the female are communicated to the male, primarily through the sense of smell, and stimulate his sexual sense by reflex action. How completely reflex sexual activity is can be proved experimentally in most of the higher gregarious mammals. If the male is kept from contact with the female, the sexual sense remains dormant. There may be certain psychological disturbances which are generally associated with abstention during times when the female is usually in season, but sexual behaviour itself never becomes apparent. Also, if the sense of smell is destroyed, it can take several years before the sexual sense can be stimulated by sight alone, and even then there is a marked lessening in its responsiveness and vigour. If sight and smell are removed, the sexual sense is rendered permanently inoperative.

The chacma can be excited without natural outward stimulus, and even when all sensory contact with the outside world is cut off (except taste and touch) the sexual sense can still become active and find expression in behaviour. It would seem, therefore, that in the soul of the chacma these pleasurable sensations have become an ordinary causal memory and the sexual sense reacts to that memory. The chacma is, in other words, capable of being excited from within and is no longer dependent upon outward stimulation. This circumstance is responsible for a great deal of what is unusual and unnatural in the sexual behaviour of the species.

It is hardly necessary to state that the baboon is anything but monogamous. Indeed, a leading characteristic of their sexual life is an apparently inherent and insistent desire for change. Mating always commences with a great show of sexual passion, often more noticeable in the female than in

the male. At this early stage the male is more genuinely altruistic than in any other relationship, with perhaps one exception: his care and defence of the young members of the troop.[1] He will guard the female of his choice with the utmost devotion and will even on occasion allow her to share his food – the highwatermark of baboon unselfishness! This devotion lasts for perhaps a week.

In the female it may be of longer duration, but in the conscience of the male, conjugal fidelity has an airy existence. His roving eye soon begins to rest appraisingly upon the unattached females – if such there be – and, like a lordly pasha, he graciously permits them to display their charms competitively before him. What exactly determines his final choice is hard to surmise. Certainly there is no trace of human aestheticism under similar conditions. Youth and its comeliness have no especial attractions for him. As often as not, he will discard a lusty young female for some ancient harridan, grey and scarred, who ought, judged even by a baboon standard, to be considered unspeakably ugly.

Nor is the female quite free from the reproach of conjugal infidelity – of an even worse type, because with her the element of furtiveness often becomes conspicuous. It is true that in many instances she will endeavour to retain the wandering affections of her mate by all the blandishments common to her sex, and will sometimes fall into paroxysms of jealous rage directed against her newly selected rival. But this single-hearted devotion to the temporary lord of her choice rarely illustrates her whole 'love life'. She is frequently guilty of the grossest infidelity while the devotion of her master is at floodtide, and we had many opportunities of studying her behaviour under these circumstances. The object of her guilty passion is generally some young male,

1. High altruism also appears in battles in defence of the troop. Dogs and even leopards are sometimes attacked by the big males with reckless courage.

nervous and extremely discreet, who has been watching the antics of the paired couple from a safe distance. With cleverness worthy of a better cause, the female will take instant advantage of a little laxity in her mate's watchfulness and entice the young cavalier to some safe and hidden spot, there to indulge her illicit passion. Even the female who never seems to be unfaithful generally accepts with complacency the sequestration of her master's affection and she invariably calms down very quickly after her initial exhibition of jealous temper.

There is a continuous decline in sexual passion – in the male especially – as each mating runs its course. It becomes apparent that he suffers from *ennui*. The everlasting sameness begins to pall. It ends in complete indifference, abstention and even aversion, before the separation *a mensa et toro* is complete. But the scene alters when his overtures have been accepted by a new female. Then his passion is once more characterized by its original vigour. Nor does the female after such a divorce spend her days in unprofitable repining. She seeks, and generally soon finds, solace for her lacerated affections in the embrace of some other male.

It will be realized that in such a community male parental affection as it exists among monogamous animals is an unknown quantity; is inconceivable, for even if true parental affection did exist, it would indeed be a wise baboon father who knew his own child. But a form of it does exist, and it is under the stress of this that males attain their highest manifestation of pure altruism. What, in the nature of things, they lack in individual parental affection is quite made up for by a common concern for all the young ones of the troop. It is a potent and real passion. The big males will cuddle and caress the young indiscriminately and will carry the heavier ones on long marches or flights after the mothers begin to show signs of exhaustion. If an infant is separated from its mother on the sudden appearance of danger, she will, if ex-

tremely hard pressed, desert her child – but only if the big males happen to be in her vicinity. She seems to know and to expect that they will carry it out of danger. And this they do, sometimes fearlessly and even recklessly risking their lives in the attempt to save a young one. If the big males are not present, the mother will desert her baby only as a last resort and never until she has made some attempt to hide it.

ABNORMALITIES

Duration of intercourse. It will have been gathered from the foregoing that for the male chacma there is practically no cessation of sexual intercourse. It is continuous throughout the year, unlimited by either season or organic conditions.* But in the female sexual intercourse is, generally speaking, limited by pregnancy, although she certainly continues for a considerable period after conception. The actual time, however, varied greatly and it was difficult to arrive at an average under natural conditions. However, one thing was beyond doubt: intercourse continued for a longer period after conception than in any other mammal. In some extreme cases it took place at an advanced period of gestation.[2] We even saw a case of abortion which my colleague was inclined to attribute to this extraordinary practice.

Barrenness in the female. There were only four mature

* This would be true only in as abnormally large a troop as Marais lived with, since in smaller troops fewer females limit opportunity. – R.A.

2. It seems hardly necessary to point out that this is to the naturalist a startling abnormality. The inflexible rule in nature is that sexual intercourse ceases as soon as conception has taken place. Not that the female purposely avoids the male, but she cannot excite his sexual sense. The domestic animals afford the only exception among the lower animals.

females in our troop who had no babies and who did not give birth to any during the period of our observation. One of these will be described next as an example of gross physical and sexual aberration. One of the remaining three was the only individual in the troop who had an obvious physical disease: a large swelling on the side of the neck and throat. She was afterwards shot and it was found that the appearance was due to the enlargement of the right lobe of the thyroid gland, accompanied by a calcereous deposit. The degeneration was recognized by an expert as characteristic of goitre in the human subject.[3]

As in the normal males, so in these barren females sexual intercourse suffered no seasonal interruption.

Monstrosity. The fourth barren female was remarkable as regards both sexual and physical variation. She was the largest and heaviest member of the troop. I have certainly never seen as big a baboon anywhere else. She must have been extremely old. The hairs on the head and chest were quite grey, and at a distance appeared white. With the exception of sexual activity, her behaviour was quite masculine. She was originally mistaken for a male and classed as such in our records.

She was especially interesting because in sexual behaviour she was normally feminine, but in our mistaken classification she appeared to be the only instance of complete inversion of the sexual sense lasting into maturity. She associated with the dominant males only, took part in their battles and raids, and in times of danger showed real masculine courage and determination. Even after we discovered her true sex, she was still of interest, as regards both her sexual behaviour and her unending and restless activity. Her great bodily strength gave her a baboon right of interference in any mating which

3. There were at the time several cases of human goitre in the vicinity.

attracted her attention, and these were of daily occurrence. With determined threats of violence she would capture and carry off the unfortunate male and by the same means enforce his fidelity for perhaps half a day. When her true sex was discovered she was nicknamed 'The Prostitute' by a native servant and retained this title of distinction to the end.

After her behaviour had been carefully noted, she was separated from the troop and shot. It was then found that the shape of the body and musculature were normally masculine. The masculine occipital and orbital ridges were excessively developed and the condition of the masculine canine teeth testified to her great age. The mammae were quite undeveloped and masculine in shape. On dissection, no trace of hermaphroditism was disclosed. The ovaries and sexual organs generally were normally feminine.

Sexual periodicity. Sexual periodicity in the female chacma is generally of irregular occurrence, and frequency seems to be to a great extent determined by environmental conditions. During droughts and times of food scarcity the irregularity seemed to increase and the frequency to lessen. The opposite occurs during times of plenty and ease. The time of greatest sexual excitement in both male and female coincides with the sexual period in the female. In this the behaviour of the chacma is similar to that of all the non-primate mammals, but there the analogy ends.

Outside the order of primates, sexual activity is strictly limited by the duration of this period in the female. Even when conception does not take place, the organic changes which constitute the condition run a certain definite course and then cease, whereupon all intercourse stops. In other words, sexual activity in the male is only reactive to the sexual condition in the female, and in the absence of that definite stimulus it remains dormant. In many gregarious

mammals, males under natural conditions exhibit certain secondary types of sexual behaviour during the time the female would be in season, apparently even in her absence. 'Calling', restlessness and fighting with other males often reveals profound psychic disturbances. But one rule remains absolute in nature: there can be no excitation of primary sexual activity in the male without the presence of the female when her organic changes are in progress.

The behaviour of the chacma affords startling exceptions to this rule. Although the sexual period in the female initiates the greatest activity of the sexual sense in both male and female, intercourse is not limited by that occurrence. It can and does frequently take place outside the period; and although conception automatically puts an end to the condition in the female, conception itself, as I have said, is no immediate and final bar to further sexual intercourse, as is the case with all other mammals.

In most of the lower African primates the sexual period is characterized by turgescence in the female and a great increase in the brilliant sexual coloration which is generally common in both sexes. In the chacma this coloration is very inconspicuous when compared with that of lower forms. In the male it is absent and in the female it occurs only during the sexual period. In the African anthropoids it has been permanently lost in both sexes.

It is quite evident that in the lower mammalia the sexual period serves one, and apparently only one, beneficial purpose. The accompanying discharge is highly odoriferous and powerfully excites the sexual impulse in the male through his sense of smell. Where the sexes are normally segregated during the sexual period the males are able to follow and find the females, though often separated by vast distances, guided solely by the compelling odour. So it seems clear that the vivid sexual coloration in the primates, which invariably attains extreme brilliance in the female during the sexual

period, is intimately connected with the degeneration of the sense of smell. None of the higher South African primates can trace the female by the sense of smell alone. A male chacma was not excited by a female during the sexual period when she was hidden a few feet from him behind a screen of matting. However, the moment he was allowed to see her sexual coloration he became strongly excited. It would seem, therefore, that as the sense of smell decayed, an appeal to the sense of sight was selected in its place. And in the chacma, the anthropoids and man (in whom the sexual sense can be excited without the need of any outward stimulation) even this sexual coloration appeal to sight has either been lost – as in the two latter species – or has become of comparatively little importance, as in the chacma.

It seems certain that somewhere in man's phyletic history this appeal, first to smell by means of sexual odours, and thereafter to sight by means of sexual coloration, must have existed. It would be difficult to account for the persistence of half-oriented survivals in the human being on any other assumption. Deep in his psychic history lies the cause which determines his 'aesthetic' taste in colour and perfume. And this taste is beyond a shadow of a doubt sexual in origin. Not by mere chance does the lady of Babylon select her glowing raiment or make her person fragrant with castor, musk and civet – the sexual perfumes common to all the lower mammalia. Dr Havelock Ellis (*Man and Woman*) points out that in many women the whole skin becomes fragrant during the sexual period. This is clearly an organic survival which accompanies the psychological one I have described.

The gradual modification of the female sexual period in the primates can be studied in practically all its stages in existing species. In many lower forms the discharge is odoriferous and still serves to excite the male through his sense of smell. As one ascends to higher forms, the odour is lost and colour, often excessive and flamboyant, takes its place. There is

always an accompanying and proportionate degeneration of the sense of smell. In the male the sense no longer serves any great sexual purpose, and in these higher forms it is also difficult to see any anatomical or environmental use in the female discharge. These modifications have reached an extreme point in the African anthropoids and man.

Birth. The female chacma about to give birth often separated herself from the troop and selected some secluded spot for the purpose. We noticed on several occasions that where she was accompanied by an independent older offspring she would persistently and often cruelly drive it away from her a few days previously. This always served as a sure indication that the birth was about to take place.

The degree of pain accompanying birth varied greatly. In some individuals – even in a first pregnancy – the infant made its appearance with ease and celerity and a minimum of trouble and pain, comparable only to the more happy condition of the lower mammals. In other cases there was deep maternal suffering quite human-like in its intensity and its methods of expression. It seems, however, quite beyond doubt that birth-pain is more severe in the chacma than in any other mammal outside the order of the primates. Some degree of pain apparently always exists in vertebrate reproduction; but there certainly seems to be a gradual increase in intensity for the higher mammals through the lower primates to man.

It is hardly possible to consider these facts without coming to the puzzling question of origin. Why should pain have been selected at all in connection with this supreme function of organic existence? What benefit was there to the individual or the race? There can be little doubt that in lower forms of organic beings the process of reproduction is as simple as it is painless. Where, for instance, the expulsion of the ova takes place as simply and with as little accentuation

in behaviour as any ordinary vital process, the presence of any sensation approximating pain is hardly conceivable. And it is in these cases where reproduction is unaccompanied by any manifestation of pain – where even the fertilization of the ova is left to chance – that there is also an entire absence of the maternal instinct. The fate of the embryo is left to the tender mercies of its natural environment and the device of producing vast numbers has generally been selected, in place of the later-evolved maternal care, to ensure the continuation of the species. It is only in higher forms, with a greatly reduced birth-rate, that the first indications of birth-pain are met, and as a sure and proportionate accompaniment there is always the care of the immature young by the mother. It seems safe to say that among species under natural conditions the greater the birth-pain, the higher becomes the maternal instinct.

Now, it is a rule in nature, which will be familiar to every student of comparative psychology, that every hereditary instinct needs an outward suggestion or stimulus to bring it into operation. The stronger this suggestion is, the more potent is the reaction of the instinct. This is especially so with instincts which become active in the mammalia only at a late stage of development, such as those connected with the procuring of food and the sexual sense. These cannot originally become operative except in response to a stimulus from without.* This seems to me the selective purpose of birth-pain among higher organic forms. It serves to call into instant activity the maternal instinct. It seems reasonable to assume that in order to ensure the safety of the offspring – a thing of supreme importance to the race – an appeal should be selected to the most compelling sensation of which higher organisms are capable, and that this compelling sensation should serve the purpose of fixing the mother's attention on

*Contemporary ethology of the Lorenz-Tinbergen school speaks of the releaser and the innate releasing mechanism. – R.A.

her helpless offspring and calling into being the complex of emotions constituting the maternal instinct.

The connection of birth-pain and maternal love is apparent as a dimly conscious idea in the human soul. In the first 'yearning' over her newborn babe, I suggest, there is often strongly present in the mind of the human mother a conviction that the love and tenderness she feels has some sure but dimly understood relation to the agony she has endured. The literature of all peoples and all times bears witness to this association of ideas.

At different times we observed and recorded several facts about mammalian reproduction which tended to corroborate this interpretation of the phenomenon of birth-pain. For instance, one season we kept under observation a herd of cattle and a flock of sheep in which the 'casting away' of calves and lambs was prevalent. The majority of the mothers who obstinately refused to receive or recognize their offspring were among those which we had classified as having had an 'easy and painless birth'. Those with a strong and correctly directed maternal instinct were invariably individuals which had shown suffering during parturition. It seemed as if in these cases the strength of the evoked instinct was in proportion to the degree of pain suffered.

Immature intercourse. The chacma often showed primary sexual activity sometime before reaching maturity and we recorded actual intercourse between immature males and females on several occasions. Even more startling was what amounted to forced intercourse between mature males and immature females. During our observations several such instances were observed, and they resulted in severe injuries to the immature female because of her desperate resistance and the violence of the mature male. These seemed to be in the nature of impulsive acts and were not characterized by the usual mating behaviour of the males. There was no evidence

that this process was ever repeated by the same two individuals, perhaps chiefly due to the terror inspired in the young female by the first attempt. She took good care that there was no opportunity for a repetition. Other instances were observed where the dominant males intervened in the defence of a threatened immature female, and it is possible that these unnatural assaults would have occurred more frequently had it not been for this deterrent.

Homosexuality. Actual homosexual intercourse occurred among the young males that had just reached sexual maturity. It seemed that their inability to secure mature females until fighting powers were fully developed (and that was always long after sexual maturity) may probably have been one of the causes of this behaviour. But it must be borne in mind that the disadvantage which young males suffer in the sexual struggle is common to all the higher mammalia and yet outside the order of primates one looks in vain for actual homosexual intercourse under natural conditions. It is more likely that the real cause is psychological and is because the sexual sense in the chacma can be excited without natural outward stimulus. In homosexual encounters among the chacma, the younger and weaker male always voluntarily assumed the female role and the older and more mature, the male.

Similar homosexual tendencies were observed in immature females. Here it was always the outcome of long-established affectionate friendship. The physical completion of the act was, of course, impossible and it seemed more like an impulsive action in which there was no real sexual excitement involved. In this respect it differed very widely from male homosexual intercourse. This behaviour is, I think, very closely allied to a tendency often observed in captive baboons: attempted intercourse with non-primate mammals – that is, with domestic animals irrespective of sex. Both male and

female chacmas reveal this tendency on occasion, accompanied by strong excitement.

A study of chacma behaviour makes it seem more than likely that the attitude of sexual exhibition, which is common throughout the mammalia and absolutely hereditary, has some connection with both male homosexual tendencies and intercourse with non-primate animals. The attitude of sexual exhibition is common and identical in both sexes of the chacma. Artificially reared babies adopt it from their earliest years. It is the common attitude not of sexuality but of conciliation both in captivity and under natural conditions, and is generally adopted in captivity for the purpose of begging or imploring. When a larger and stronger individual, male or female, pursues in anger a smaller and weaker baboon of either sex, the latter when cornered or exhausted will invariably assume the attitude of sexual exhibition. Its effect is often instantaneous and very remarkable. The anger of the pursuer usually subsides at once, and in most cases where the rage of the pursuer is not excessive, the threatened individual will escape chastisement by the adoption of this method of imploring pity. But its psychological effect is evidently varied. In most cases the pursuer becomes calm, and there is no behaviour to show that he takes any further notice of the object of his anger. In some cases, however, the attitude has the effect of immediately arousing the sexual sense of the pursuer and consequent behaviour clearly shows that sexual feeling is instantly substituted for rage. It is true that we never saw consummated homosexual intercourse under these conditions, but tentative efforts were common. It seems unlikely, therefore, that the homosexual habit (if we can speak of it as such) is acquired as a result of this behaviour. But all these circumstances certainly do seem to co-operate in the creation of homosexual habits. They are in the nature of favourable environmental circumstances reacting on a predisposed psychological condition.

One more observation remains to be mentioned which, from an analogous result in the case of man, would lead one to infer that it also had a great influence in establishing homosexual tendencies in the male chacmas of our troop. It must be made clear that the troop was completely isolated and had apparently been so for many years, and during the period of our observation the mature males always exceeded the mature females in numbers. In man the absence of females is undoubtedly a determining factor in the establishment of homosexual tendencies. Professor Edvard Alexander Westermarck (*Origin and Development of Moral Ideas*), who of all modern writers has compiled the most systematic, perhaps the most complete history of homosexuality from the anthropological point of view in man, repeatedly traces homosexual practices to this cause.*

Another interesting observation we made was in connection with acquired homosexuality and inversion of the sexual sense. No chacma, either in captivity or under natural conditions, exhibited a congenital and unchangeable inversion, nor was there any case where long-continued homosexual practices brought about an inversion. In all cases, as soon as heterosexual intercourse commenced, all homosexual tendencies ceased.

Whatever the condition of man may be, it seems to me very unlikely that there is such a thing as congenital inversion of the sexual sense in the chacma at all, or that acquired homosexuality in this primate exercises any permanent mod-

* Contemporary primate students discount actual homosexuality in the wild baboon. The postures Marais observed, common not only in primate but in rodent species, seem to be performed in a social rather than sexual context. He was correct in his interpretation of conciliation, and he may well have been correct that the abnormal structure of his troop encouraged abnormal practices. But all observation today would indicate, for example, that the mounting by one male of another tends to be an affirmation of social dominance on the part of the one, social submission on the part of the other. – R.A.

ifying effect on the sexual sense. We certainly obtained no evidence justifying such a conclusion.

Deorientation. While investigating the extent to which phyletic memories persist in the chacma, we came across the wholly unexpected fact that there are cases in which there is absolutely no hereditary orientation of the sexual sense. These experiments had necessarily to be made with artificially reared baboons. We found that in about half our subjects the most vital instincts were not transmitted, as they are in the lower African primates and in all non-primate mammals. These subjects did not know their natural food, nor when or how to look for it. They could not recognize any environmental danger, could not distinguish beasts of prey and showed no fear of snakes – the one thing that was certainly and strongly hereditary in many individuals. They were, in fact, quite helpless when released in their natural environment. What is known of the psychology of the anthropoids led us to anticipate some such condition in the chacma. But nothing had led us to anticipate that primary sexual behaviour would be other than hereditary.

The individuals lacking this most essential of all phyletic memories after attaining maturity had to gain their sexual knowledge with great difficulty under direct and continued suggestion. They had, in fact, to learn all that was necessary for sexual intercourse, just as they had to learn a new relation of cause and effect. Invariably the sexual sense was powerfully excited by a female, but there was absolutely no hereditary knowledge of the natural method of satisfaction. There is every reason to believe that this loss of the inborn direction of the sexual sense has proceeded much further than in the chacma. Whereas in the latter species the individuals who show a complete absence of all instinctive knowledge are rare, in man probably the great majority are subject to this singular psychological degeneration. And when we

come to secondary sexual behaviour, then it is quite certain that no single human being comes into existence with any trace of inborn knowledge.*

In the lower primates and the mammalia in general, each individual is born completely equipped with both primary and secondary sexual direction. They know without the need of any experience or teaching the natural method of satisfying the sexual sense, they know the right season, the period of abstention and all the organic conditions of the female that begin and end sexual intercourse, and the behaviour is always identical in all individuals. Man has to be taught all this, and the teaching varies as widely as the races of mankind do. Most savage races have initiation ceremonies during which primary and secondary sexual behaviour is taught to both sexes as they reach maturity, and I do not think that there are any two tribes in which the teaching is identical. And what the savage teaches in sexual behaviour would certainly not find favour in our existing civilizations. It is quite common, for instance, among great numbers of savage peoples to teach and provide means for homosexual relations just as if they were the natural expression of the sexual sense in man. The teaching varies just as widely on such questions as monogamy, the continuance of intercourse after conception has taken place, cessation during menstruation, etc.

Two things are apparent in both the savage and the civi-

* Marais seems to have been the first to discover the sexual helplessness of primates raised in isolation from their kind. Similar observations by others furnished psychology with its argument that man has no instincts, and that even sex is learned behaviour. Only in recent years has it been demonstrated that the problem is not one of learning, but of neurosis. Male rhesus monkeys raised in isolation by Harry F. Harlow at the University of Wisconsin have been incapable not only of sexual orientation but of intromission. Yet rhesus orphans, raised without adult contact but with opportunity to play together, display no sexual inadequacy. To my best knowledge, there has not yet been an experiment with baboons. – R.A.

lized sexual teachings of man, and both are of supreme interest to the comparative psychologist. First, there is a laborious striving after more natural behaviour. In other words, man bearing no knowledge within himself strives and strives to imitate the sexual behaviour of the lower animals. In all so-called scientific teaching as well, such behaviour has been set as a standard. It is, of course, the only standard available.

The second interesting fact is the idea of something wrong, something evil in the sexual sense itself. It is certainly apparent in all great religious systems. In Buddhism abstention is a virtue – indulgence a source of spiritual pollution. In the Mohammedan and Jewish religions sexual intercourse causes ceremonial impurity. The Hebrew myth of Adam and Eve has as a central idea the inherent evil of sexual intercourse. It is a forbidden thing, not only a sin in itself but imparting its contaminating influence to the individual resulting from it. The idea reaches its supreme point in the Christian religion, where it is regarded as an undesirable evil. The Apostle Paul teaches that it is a hindrance to man's spiritual regeneration, and in the Fourteenth Chapter of the Revelation of St John the Divine, the description of a multitude of souls redeemed from the earth reads: 'These are they which were not defiled with women; for they are virgins.' Hence, too, the doctrine of the immaculate conception and the continuous virginity of Mary. Christ, born of no natural sexual intercourse, was the one being who appeared on the earth uncontaminated by this thing that had fallen upon man as the primal and supreme curse.

But these ideas underlying man's sexual teaching, the idea of a natural standard and the idea of inherent evil in sexuality itself, are of interest to the comparative psychologist for the reason that both conceptions reveal the extent to which deorientation has progressed and the teaching become an ambiguous instruction. Phyletic memory being incom-

plete, man must look to causal memory for an answer. And man is left without firm moral direction derived from natural order.

Masturbation. Masturbation in some troops occurred among the younger mature members of both sexes. Outside the temporarily paired adults the average was somewhere in the neighbourhood of ten per cent of those sexually mature. Masturbation was more certainly idiosyncratic than homosexuality – that is, it was more certainly a *habit* of the individual and not, as in the case of homosexuality, apparently a tendency to which all were at times subject. It was often observed in our wild troop under certain definite circumstances. A young male would fall in love with a much older mated female, and would follow her persistently at a considerable distance. Any sexual advances by the older male who at the time happened to be the master of her affections would throw the watchful cavalier into a state of intense excitement, which, however, never exceeded the bounds of extreme discretion. Under such conditions masturbation was frequently resorted to. It sometimes happened that the female in question would make secret advances to her distant admirer, but if masturbation had become a habit he would very rarely take advantage of this natural means of satisfaction. The approach of the female would induce a state of nervous apprehension and he would generally assume the female sexual attitude, which was apparently protective. But if the young male had not resorted to the practice of masturbation, he would invariably take immediate advantage of the proffered natural means of satisfaction.

It must not be inferred, however, that these circumstances always accompanied or preceded the practice of masturbation in an individual. The most that my experience justifies me in saying is that we observed the connection between this definite set of circumstances and the practice in a great many

instances. My colleague was inclined to the view that where the practice was indulged in for any length of time before the male succeeded in attaining sexual satisfaction naturally, it had certain well-marked neurotic results. Such an individual became solitary in his ways, morose, and vicious in temper. Physically, too, there was almost immediately a falling off in condition even when food was plentiful. I was not quite satisfied myself that this did occur under natural conditions. In captivity there is no doubt that the habit invariably produces a morose and vicious temper.

About two per cent of those addicted to the practice of masturbation at any one time were females.

Among older mature adults who had already mated it was never observed, but in captive baboons kept under conditions where the natural means of sexual satisfaction were wanting, masturbation was far more common and had no age limit, and very often the habit could be directly traced to initiation by example. On the other hand, we could not find any absolute proof that the habit ever occurred spontaneously in any individual. It is quite possible that it may have been conveyed to certain troops by baboons who had acquired the habit in captivity. Among wild troops living remote from human habitation it was not observed.

Sexual impulses in captivity. A noticeable fact among baboons kept in captivity was the predominance of the sexual sense in older females kept from contact with males. This rose to fever pitch during the sexual periods. At such times a female will eagerly and persistently offer herself to every male human being who approaches her. She distinguishes between male and female, and towards women she often shows a vicious hostility. Masturbation in such cases – when it does occur, and it is very rare – seems to be generally a reaction to strong physical irritation.

In man the metamorphosis of emotion is even rarer than in

the chacma. The best-known examples are the sexual perversions known as masochism and sadism, respectively. In masochism pain and humiliation are changed into sexual excitement, and in extreme types of sadism there occurs a transformation of sexual excitement into rage and bloodlust.

It must not be thought that by using the word 'transformation' any theoretical psychological explanation is implied. I must acknowledge that the tendency is a mystery to me. From an evolutionary point of view I am unable to explain it, and we found no facts from which its phyletic history could be inferred. The earlier observers into human sexual abnormalities explained sadism on the theoretical assumption that the sex and anger centres are nearly related and that in these cases either the stimulus is sent to the wrong centre, or the excitation of one centre affects the other, or the stimulus excites the nearly related afferent nerves much in the same way as an induced current does. The evolutionist would describe sadism as a phyletic survival of which the origin is seen in the sex-battles of the lower animals, and that is perhaps the same thing in other words. But even this explanation, such as it is, becomes doubtful when one realizes that in lower primates the tendency is much more pronounced and that emotions are involved which are not in any way related.

So ends the Marais manuscript.

Just as a remarkable guest, one of vision and many anecdotes and a remote madness, might spend an evening by our fire, then glance at his watch and rise, so Marais takes his leave. There is a suddenness that is part of our knowledge that we shall never see him again. And we watch through the curtains as our visitor from times past walks down the path, touching things with his cane. Beyond the gate he turns down the road to the right, swinging his cane more freely. He

passes under a street-lamp and vanishes in the darkness beyond the trees. Whom else did he ever visit? Where else did he go?

ROBERT ARDREY

THE SOUL OF THE WHITE ANT

Translated by Winifred de Kok

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LIST OF ILLUSTRATIONS

I

THE BEGINNING OF A TERMITARY

SOME years ago an article about 'White Ants', as termites are commonly but incorrectly called, appeared in a South African journal. Almost everything that naturalists tell us about these insects is important and interesting, and Dr Hesse's article was exceptionally so. But the article also made another fact clear; how very little is done in our land to study the behaviour of animals, and how much has been done and is being done in other countries. Everything that Dr Hesse told us was the result of long and patient observation in America and Europe. None of his facts was exactly relevant to our South African termites.

The life-history of most of our South African ants and termites is in every respect just as wonderful and interesting as anything that has been discovered in South America. Over a period of ten years I studied the habits of termites in an investigation into animal psychology. I then realized that such observation reveals new wonders every day. To mention one instance, the functioning of the community or group-psyche of the termitary is just as wonderful and mysterious to a human being, with a very different kind of psyche, as telepathy or other functions of the human mind which border on the supernatural.

When one wishes to write of all these wonders, one is bewildered by the *embarras de richesses*. It is hard to know where to begin.

I want to tell you about the commonest of our termites or 'white ants', and what I am going to relate may be observed

by anyone who wishes; he may even discover new wonders. Most of these facts have not been published before; indeed, I do not think they have been discovered by scientists.

The common termite which is so destructive to wood of all kinds, and builds 'ant-hills' or termitaries on the open veld, is known throughout South Africa. I will tell you a little about the beginning of its community life.

The beginning of a termitary dates from the moment when the termites fly, after rain and usually at dusk, in order to escape their innumerable enemies. Even here we see a remarkable instance of the wonder of instinct. The termites beginning their thrilling flight know nothing about enemies. They have never been outside the nest before. The peril of existence is to them a closed book, and yet nine times out of ten they do not fly until the birds are safely in their nests.

These flying termites are at least twenty times as big as the others of the nest, and quite different in colour and form. You must consider a termitary as a single animal, whose organs have not yet been fused together as in a human being. Some of the termites form the mouth and digestive system; others take the place of weapons of defence like claws or horns; others form the generative organs. These flying termites are the generative organs of the colony. Every one of these winged insects is a potential king or queen. The four beautiful wings have taken months to develop and grow to perfection; months elapse – or even years in very dry districts – before an opportunity for flight occurs. They will never fly until there has been rain, and the reason is obvious. After the flight they must seek immediate shelter in the ground, and when the ground is hard and dry this is impossible.

Follow the flight of the termites carefully from the moment they emerge from the nest. They crawl out of a little opening, thousand upon thousand. There is obviously much excitement in the termitary. Sometimes the flyers are es-

corted to the opening by workers and soldiers. The first impulse of the flying insect as it emerges is to try its wings. It flutters and essays to lift itself into the air. If it fails, it climbs a grass stalk and takes off from this height. But fly it must, even if it is only for a few inches. You will understand presently why this is so essential, just as necessary as the preservation of its life, and therefore it takes just as much trouble to fly – even more perhaps, for the urge is greater – as to protect itself from enemies.

The watcher will soon become aware that the object of the flight seems to be to spread the insects over as large an area as possible, as some plants disseminate their seed. Some of the termites rise high into the air and travel for miles before they settle; others sink to the ground only a stride or two from the old nest. But far or near, fly they must, or the sole object of their existence is frustrated.

Let us watch one of the ants which has flown and settled in the grass near at hand. We will suppose it is female – the two sexes cannot be distinguished with the naked eye. The first thing she does is to discard her wings. This she succeeds in doing by a lightening-like movement – so fast that we cannot follow it with the eye. One moment we see her with her wings intact, the next moment she steps away, and her four wings are lying on the grass – she is much, much quicker than a woman who discards her evening gown and hangs it over a chair. It took months for her wings to grow. For years perhaps she has lived in subterranean darkness, in preparation for this one moment. For a period of three seconds, for a distance of perhaps three yards, she enjoyed the exquisite thrill of flight and with that the object of a great preparation has been fulfilled and the fairy-like wings are flung aside like a worn-out garment.

Immediately the wings are discarded she walks about rapidly for a few seconds. You become aware that she is seek-

ing a suitable place for some further purpose – but you do not know what the purpose can be, and her immediate behaviour does not clear things up for you. You must watch patiently if you wish to discover what she intends doing. When she has found a suitable spot, she does a very peculiar thing. She comes to rest on her fore-feet and lifts three-quarters of the hinder part of her body into the air, and she remains stationary in this position, as still as if she were merely the statue of a termite. If you become impatient and walk away the secret of the flying termite will remain a secret to you for ever. What is she doing? She is busy sending a wireless SOS into the air. Be patient a little longer – there are only very few people who have witnessed this miracle. What does the signal consist of? I *think* I know, but I doubt if you will guess what it is. Only if you have made a study of the signals of insects will you find the clue. You think, of course, of some sound which cannot be heard by the human ear. You may know how our little South African *toktokkie** beetle knocks in similar circumstances. No, the termite's signal is not a sound. One can prove that by experiment. We will content ourselves for the moment with the fact that the signal consists of something far and away beyond our own senses, and yet the male becomes aware of it over incredible distances! How does this happen? Well, it *does* happen, and our female is a very modern young woman, not too shy to make the first move in love-making. If you wait long enough you will presently see another termite come flying through the air, and you will notice that although his flight appears awkward and almost involuntary, yet he can steer a course and choose a direction even against the wind. The male sinks to the ground sometimes a yard or two from the place where the female is standing motionless in her curious posture. As soon as he lands he makes the same lightening-like movement which we have

* A beetle of the genus *Psammodes*.

already seen in the female, and there on the ground lie his wings, too. His haste is terrible and irresistible. Over and through the grass he crawls, so fast that we can barely follow him with our eyes. He is looking for the originator of the signal which he received high up in the air. Within a few minutes he has found her. She has been motionless all the while, with her body hoisted aloft, but the instant the male touches her with his antennae, he infects her with his own excitement. She begins to run away as fast as her legs will carry her, and immediately behind her comes the male. They are now beginning the final search – they are house-hunting, and this the male leaves to his wife. It must be a good house, for they will live in it for a long time. And with the finding of their home and the digging of the front door we will leave the happy pair for a while.

There are even stranger things connected with this little drama, of which the inexperienced observer will not become aware. I spoke of the urge to flight. Listen carefully. If those two termites had not flown, none of the events we have watched would have occurred. Instinct is something which only works step by step. If you destroy one step or omit it, then the whole thing collapses. Nature wishes the 'white ant' to spread. If the nests are too close together it would be bad for the communities; therefore they receive wings and must fly. But flight is only one step in their sexual life; if this step is omitted, their sexual life and their very existence ends there and then.

For as long as two years the two sexes may live in the same nest after they have grown wings. They are in constant touch with each other but there is not the least evidence of any sexual life. They *must* crawl out of the nest, they must fly, must settle and lose their wings, then and then only, and then immediately, sexual life begins. If you prevent them flying and break off the wings, both male and female die

without any further attempt to become progenitors of the race. The length and distance of the flight is of no importance; it may last hours or only a second; it may cover miles or only an inch. But the force which we call instinct commands – you *must* pass through every stage, you must take every step, or you are doomed. If you take a male and female just as they are emerging from the nest and place them beside each other, even in the closest contact, you notice that they take not the least interest in each other. They struggle to get away from each other. Let the female fly a few inches and the whole process which we described is carried out to a finish. Let the male circle round even once, then force him to land near the female, then and then alone, will events take their normal course. A second in time, three inches in space, one flutter of wings, are to the termite a gulf as wide as infinity dividing two kinds of existence. To us it may appear only a small dividing line, but the insect *may* not overstep it, not even with human assistance.

2

UNSOLVED SECRETS

THERE is much to be told about the building of the termitary, but I will confine myself to behaviour which is important for purposes of comparison. All behaviour is of importance to the psychologist. Behaviour *is* psychology – at least it is all of the psyche we know or can study. For purposes of comparison, for comparative psychology – especially if you begin at the top of the ladder with the apes – the field at our disposal is not very large.

Upon the king and queen themselves falls the task of feeding and attending the first children. After the latter are full-grown they take upon themselves all the work of the community. In the meantime the queen grows larger and fatter by the hour. Her small neat body vanishes in increasing layers of fat until at last it becomes an unsightly wormlike bag of adiposity. And to heighten the tragedy, her mate, in addition to having the blessing of almost the only *dolce far niente* existence known to nature, appears to have discovered the secret of eternal youth. He remains as beautiful and active and young as he was on his wedding flight. But if you look at her, an immovable disgusting worm, it seems impossible to believe that she ever fluttered in the air on fairy wings. We could hardly blame his majesty if he began casting an eye at some other female a little less repellent. If you fear this, however, you will be pleasantly surprised. His attachment to his queen seems to keep pace with her own growth. If you lay open the palace cavity, he rushes round in consternation, but always returns to her side. There is no question of saving his own life in flight. He clings to her gigantic body and tries to defend it, and if the ruthless attacker

so wills, he dies at her side. What a wonderful example of married love and fidelity, which can survive this terrible change of his beloved to a loathsome mass of fat!

We often speak metaphorically of a queen as the mother of her people. This the termite queen is literally. She is the only mother of the millions which form the community; every individual is born out of her. Naturally she is absolved from all duty in the nursery. All she is expected to do is to keep on laying an endless stream of eggs, because the daily loss of workers and soldiers is enormous, notwithstanding their excellent methods of defence. Mother Nature is not perturbed about the death of a thousand individuals, when she has had the foresight to make certain of an unending supply.

I am now coming to a stage when in actuality every termitary differs in its growth, but for our purpose we will suppose that the environment of our nest has been such that development is entirely normal and not subjected to any disturbing outside influences. The first workers begin to build a palace for the queen. Deep below the surface of the earth, from three to six feet, they prepare a hollow chamber. As years go by this is gradually increased in size, and the earth which is excavated is taken to the surface and used to form the thick defensive crust. In this hollow chamber the queen is placed. It fits her so well that one is inclined to think that it has been built around her. I do not think this actually happens, but now I come to a stage when almost every conclusion is bound to be mere guesswork. No human eye has ever seen what actually takes place. No one has ever discovered a way in which to watch the termites at work in the queen's chamber, for they work in pitch darkness and to let light into the chamber is as great a handicap to the termites as the sudden destruction of the sun would be to us. We cannot see in complete darkness.

The queen continues growing until, compared with the

ordinary termite, she reaches a gigantic size, and becomes an immobile mass, still as a log. The only part of her which gives any sign of life is the little head, which remains unchanged. If you dissect the skin and body carefully and examine it under a microscope, you will be convinced that during her later stages of growth the queen is unable to make any voluntary movement, except of course of the head. You make think she could move like some worms do, by contraction and expansion. But you will find that no part of the body behind the head can be controlled by what was once an intricate central nervous system. Nor do I think that there can be any question of her regaining the power of movement temporarily, as for instance by emptying the sac for a while. I certainly have seen no indication of this. Besides, the very nerves in the body have changed into fluid. Both these theories, therefore, that the queen is able to move by contraction and expansion, or that she gains a temporary power of movement, must be discarded.

To continue with the queen's life-history, her first palace is a cell made of termite earth which rapidly becomes as hard as cement. Usually she just neatly fits into it. She is always much too huge to use the door of the cell as entrance or exit. If you wish to remove her you must break down the cell. The king and the workers, however, can come and go quite easily. She is fed and the eggs which she never ceases laying are removed to the breeding grounds by workers appointed to this task. The king apparently does nothing. He appears to be a mere hanger-on in the palace. Still the queen goes on growing. Here in her first palace she has not attained one-third of her eventual size. At last she very nearly fills all the available space in the cell. There is barely room for the tiny workers to carry the eggs away across the insensate bulk. A terrible tragedy appears to be imminent – it reminds us of the question: what will happen if an irresistible force meets an immovable

mass? The human observer is helpless at the threat of this terrible fate. In spite of all his knowledge and intelligence he is unable to help in any way. But actually termites have never worried about it at all. They had a solution ready – a very simple one. Just before her majesty finally outgrows her cell they build a second one, half as big again as the first. It is parallel and adjacent to the first, just as hard and with just such a narrow door. The queen is then removed and placed in the second cell where there is space for her to grow for perhaps another year. So she gets transposed from cell to cell until there have been about six changes with the queen in the last and biggest. The chamber doors are always equally small – much too small for the queen to come or go by.

We must clearly establish another fact which makes the whole matter even more complicated. One could easily prove by measurement that the queen's subjects could not possibly move her. The lifting power of one termite can be estimated fairly closely, and the area of the queen's body available for workers to grasp during lifting can be measured. During the later stages it would need thousands more termites to lift her than there is available grasping space for the body.

We present to you the following facts:

1. The queen is incapable of movement.
2. The doors of the cell are too small for her to come or go by.
3. The insects cannot lift her.
4. Yet she vanishes from one cell to appear in another.

The only explanation that seems feasible is that there are several queens and that it is not the same one each time. If the first gets too big for her cell, she is killed and eaten and then the workers carry a potential queen into the second cell where she develops into a queen. The only intelligent explanation, perhaps, and very simple, now we have thought of it.

The only pity is that it is not true. We have been deceived by the analogy of the bees, which make queens, kill, and move them. It is quite an easy matter to mark the termite queen and so prove that it is the same queen which gets moved. I have tested many theories brought forward by friends who have studied entomology, but have never found one which coincided with all the facts. Perhaps one day a future Fabre will discover the truth.

3

LANGUAGE IN THE INSECT WORLD

I HAVE told you how, shortly after she discards her wings, the flying queen sends a signal into the air, which is always answered by the appearance of a male flying through the air. What exactly the signal was I did not make clear, but left it for some later opportunity. I want to talk about it now. But I am afraid there will be a long preface before I begin – perhaps the preface may take even this whole chapter. The inquisitive reader need not be disappointed, however, for I am sure this preface will prove interesting, too. In order to understand the language of animals, one must first of all learn its A B C, but of far more importance are the things you must unlearn. We will therefore begin at the very beginning.

An individual member of any animal race which wishes to communicate with another at a distance can use one of three things; colour, scent or sound. And at this point you must begin unlearning. If you think of colour and scent and sound in terms of the impression which these make on a human being, then you will be lost before you begin your journey. Listen. There is one kind of termite which constantly signals by means of sounds. If ever you have slept in a house in which those termites are at work you will know the sound well. It is a quick tik-tik-tik. You can also hear this if you let down a microphone through a hole made into a termitary. You will easily observe that not only do the termites make this noise, but that other termites at a distance hear it and immediately react to it by their behaviour.

Now catch one or more of the signallers and examine their

anatomy under the microscope. What do you find? Not the least sign or suggestion of any kind of auditory organ; not even the most primitive kind of ear; not a single nerve that could possibly be sensitive to what we call sound. We find the same as regards colour and scent. The termites undoubtedly use both colour and scent as a means of signalling – as you will see later. But again you seek in vain for any organ resembling an eye. There is not even the faintest spot of pigment which might serve as a primitive eye. The termites are quite blind, yet sensitive to an indirect ray of light far below the threshold of perception of the human eye. By this I mean they can become aware of a very diffuse light not shining directly on them, which a human eye could not perceive. This can be proved by experiment. As to any organ of smell, that, too, seems to be completely absent.

Let us now observe another insect, our dear little *toktokkie* beetle, which will take us a good way along the path we must travel, and will greatly help to explain the secret to us. If you wish to learn to know the *toktokkie* really well and to learn to talk his language, you *must* tame him. He must become so used to your presence that he never alters his behaviour by suddenly becoming aware of being observed. He is very easy to tame, at least the grey-bellied one is, and learns to know his master and love him – you know the one I mean, the smooth little fellow with pale legs, not the rough-backed one. What South African child has never seen the *toktokkie* and heard him make his knock? Your eye suddenly falls on him in the road or beside it. If he does not get a fright and fall down dead with stiff legs – as dead as the deadest *toktokkie* which ever lived – then you see him knock, and of course hear him, too. He looks round for some hard object, a piece of earth or a stone, and knocks against it with the last segment of his body – three, four, four, three! This is his Morse Code. He then listens for a moment or two, turning rapidly in many direc-

tions. His behaviour is ridiculously human. His whole body becomes an animated question mark. You can almost hear him saying:

'I'm positive I heard her knock! Where can she be? There, I hear it again!'

He answers with three hard knocks, and then he betakes himself off in great haste and runs a yard or two. He then repeats the signal in order to get a further true direction, and so he continues until at last he arrives at his loved one's side.

If you study the behaviour of many *toktokkies* during the mating season, you will occasionally have to follow one for an incredible distance in the direction of the answering signal. He can hear the signal over a distance which makes the sound absolutely imperceptible to the human ear. It is at this stage that he begins to rouse the interest of the psychologist. We study him at closer quarters. Again we find under the microscope no sign of an ear, nor complex or nerve which takes the place of an organ of hearing. But in spite of this we still think of the behaviour of the *toktokkie* in terms of sound and hearing!

Now we will go into our laboratory with our tame *toktokkies*. The laboratory is a stretch of natural veld or a fairly large garden. The observer will soon discover that the *toktokkie* is one of the most credulous of insects. When he is dominated by sexual desire, he will believe everything you happen to tell him. Knock on a stone with your fingernail – in his own Morse Code – and at once he answers. You can teach him quite easily never to knock except in answer to your signal. This you succeed in doing by not knocking for several days unless he has become perfectly quiet. After a day or two he will have learnt to knock only in answer to your signal – and will answer immediately. Now get a small microphone with headpiece and three feet of wire (you will find

this indispensable in your association with the insect world). The microphone must be so powerful that you are able to hear the footfall of a fly quite easily. When your *toktokkie* is tame and well trained you proceed to test the acuteness of his perceptions. To your amazement you find that they are unbelievably, supernaturally fine. Knock on the stone again with your finger-nail and gradually make the sound softer until it is quite beyond your own hearing. Still the *toktokkie* answers the signal at once without the least sign of doubt. Then begin knocking not with the nail but with the soft pulp of the finger. There seems to be no sound at all, but still the *toktokkie* answers! Now take the microphone and place it on the ground with the earphones over your ears. Knock on the receiver with the pulp of your finger – a real knock, not merely a pressure. With a little practice you can reduce the sound until at last it is inaudible even through the microphone, but still the *toktokkie* hears it!

The solution to this problem is: It is not sound as such which the *toktokkie* becomes aware of, and there can be no question of *hearing* it. Any book of physiology will make it clear to you that sound is only our interpretation of certain vibrations in the atmosphere. (Sound cannot travel through a vacuum – you can prove this by sending a sound through a wire inserted in the cork of a thermos flask. It will be imperceptible, except for a faint noise which escapes through the cork.) It is our ear which interprets the vibrations as sound. Beyond the ear the universe is soundless. Without an ear – or organ of hearing – there can be no sound. But the vibrations which we call sound have a physical function. It is by the exercise of physical force that the drum of the ear and the hammer and anvil bones of the inner ear are set into vibration. In the same way you can let grains of sand or a thin gas-flame vibrate to a musical note. But there is another difficulty. The sudden meeting of the surfaces of two physical

bodies can result in vibrations of the mysterious ether, which are not by any means sound-waves and therefore have no effect at all on our ears. We are getting into somewhat deep water now. I believe it is vibrations of this kind, waves in the ether, of which the ants and the *toktokkie* make use. It may sound far-fetched, but you will have to accept some such explanation if you wish to learn the language of insects. The next time you hear a 'longbreath locust' (apparently so called because it is *not* a locust and the sound is *not* made by its breath), you must not think of sound or hearing – you must think of vibrations – waves in the ether – which can be sensed by another such locust at a distance of at least eight miles. You will also have to use this theory when we return to our termite nest, or else you will be forced to think of a miracle in order to explain the communication which takes place between the outlying sections of the nest. This disposes of sound in the insect world. There are two other ways of communication which I must tell you about: Scent and Colour.

Our termites continually make use of scents, some of which we can perceive with our olfactory organ. In the Northern Transvaal there is a well-known termite known as the 'stinking ant'; this emits a foul smell to a distance of three or four yards, which has the peculiar property of causing extreme nausea in most people and also in dogs. Then again all South Africans will know the characteristic smell of the common termite. This is caused by the discharge of a gas which the termite uses for other purposes. It is of the utmost importance for us in our study of termite language to make certain of what the signal of the queen really consists. After long study, I have come to the conclusion that it consists of something which would affect our senses as *scent* if it were strong enough. Things always seem pretty hopeless in the beginning when we are dealing with phenomena which lie

far beyond all our senses, but 'perseverance pays' must be the motto of the traveller along these dark and unknown footpaths.

Here is another reason for thinking the signal may be thought of as scent. You can easily train a pointer to track down the flying termites after they have lost their wings. He will track down a signalling queen for nearly a hundred yards against the wind; with the male he finds it difficult even over the distance of a yard.

But a still more important proof will take me longer to explain. The following are all the signals used by the termite:

1. The communal signal which is constantly sent out by the queen – who forms the hub of the nest. This serves to keep the community together and enables every termite to recognize every other member of the community. It is a signal which cannot be perceived by our senses.

2. The call of the workers and soldiers. This is perceived by us as sound.

3. Food messages. (Beyond our perception.) These three we will examine more closely later on.

4. Lastly, the sexual signal of the queen, which is also beyond the reach of our senses.

We know that throughout nature scent and colour are used as sexuals. If there are no brilliant colours, you may be sure there will be some scent.

Allow me to digress for a moment. I have shown you how the termite flight is the key by which the door to the sexual life is unlocked. Without flight there can be no sexual life. In the mammals the key is generally *scent*, sometimes allied to colour. This begins in the plant. The colour and perfume of flowers is of course purely a sexual phenomenon. The apes and humans have long ago lost both. But in the other mammals scent still remains as the key which makes sexual

life possible – that is why it is possible to keep large mammals for years in a zoo or menagerie without the sexual passion being awakened. It is interesting to study our African kudus in relation to this fact. In the Waterberg I very often had the opportunity of watching from near at hand a wonderful spectacle. For a week or two every year the kudu cows become scented or 'on heat'. As soon as this passes the bulls leave the cows and segregate themselves to graze in small herds. Of course they come in contact with the cows occasionally but never evince the slightest interest. But just see what happens when the cows, in heat again, travel four or five miles to windward. A minute before all the bulls were grazing peacefully, in sleepy careless fashion. Then they get the wind. It is as if a thunderbolt has fallen in their midst. With fitful movements the beautiful heads are raised and their nostrils are snuffing the wind greedily. Their deafening bellows are heard on all sides, and immediately the whole herd, which a moment before was grazing so peacefully, is lost in a cloud of dust and we hear only the clashing of horns and bellowing of rage, because the sexual life is always preceded by the stimulation of the fighting sense. Without the special scent from the cows, their sexuality would have remained unstimulated. This can be easily proved. Take one of the smaller mammals, of a kind dependent on the sense of smell, and destroy the olfactory nerves by incision; in some cases nature does this with an ulcer. After this the male may be brought into the closest contact with the female, even in heat, but never again will he become sexually stimulated. Outside stimulation, scent or colour, is always essential to stir the sex centres. The only animals whose sex centres can be stirred without this outside stimulation are the higher apes and man. When you come to the ape and man the cultivation of scent and colour becomes fascinating and mysterious. Ask a young woman why she uses the heavenly perfumes which the chem-

ist of our day has learnt the art of producing in such exquisite perfection. Her answer will be misleading, because she does not know the subconscious reason. It is an urge which rises from the most remote recesses of her psyche, a rudimentary and forgotten instinct from the ancient history of her race. She would be startled if she heard the true story of this urge. She would feel embarrassed if she learnt that the basis of all her perfumes were the sexual secretions of several kinds of cats, of deer, and (the most expensive of all) the rudimentary sexual material secreted by a certain kind of whale which is now merely a pathological reminder of his life on the land millions of years ago. Musk is the universal basis of the scent sex signals in animals. Even in human beings this phenomenon may still be found. Our young woman will be astonished and perhaps a little envious, to hear that about one woman in every thousand still secretes musk on occasion. Her whole skin becomes strongly and exquisitely fragrant. As in the case with many such atavistic tendencies of our race history, this secretion of musk is found more frequently in individuals of the monkey or ape tribes. But that is the origin of the mysterious yearning which lovely perfumes awaken in the human being.

When speaking of scent you should again think of waves in the ether. It is false to assume that perfumes consist of gases or microscopic substances. Perfume itself is not entirely a physical substance. You may scent a large room for ten years with a small piece of musk and yet there will not be any loss in weight.

We appear to have gone a very long way round in order to find out of what the signal of our queen really consisted. In reality we avoided many deviations in the path which we might have taken. That shows us how very patient and persevering we must be to reveal the tiniest little secret of our dear Mother Nature. Now at least we are nearly certain –

never of course quite certain – that the sexual signal of the termite queen is a wave circle in the ether which in all probability would be perceived by our olfactory nerves as perfume if it could cross the threshold of perceptivity of our senses.

4

WHAT IS THE PSYCHE?

THAT which is known as the psyche or soul is something far beyond the reach of our senses. No one has ever seen or smelt, or heard or tasted or felt the psyche, or even a piece of it. There are two ways in which we can come on the track of the psyche. In my own innermost self I become aware of something which is not a tangible part of my physical body. This awareness of course is limited to a part of my own psyche. That of my brother is just as far beyond my direct reach as the psyche of the termite. I must accept the existence of other psyches because I am told of them. Introspection is thus one method by which I am able to affirm the existence of the psyche. But this is a separate branch of knowledge which at the moment does not concern us. Now we come to a question which will prove more interesting to us in regard to our observation of the termite. I will try again to be as little scientific and technical as possible. But I must enlarge on it and you must be patient and try to read it and understand it if you wish to grasp all the wonders of a termite nest, which will be revealed to you later on.

Remember that most of the important definitions which follow are my own and made on my own responsibility for what that may be worth. You will search scientific books in vain for confirmation of what I say. Nevertheless I flatter myself that, if you really study nature, not only will you find that all I say is true, but that it is the only key with which to unlock many dark secrets in the behaviour of living creatures.

Let us first see what science says. The psyche, so say scientific and very logical people, is a *state, of matter*. This was also their first definition of magnetism; you dare not say

the psyche is something which causes a certain state of matter, for there is no proof of that. But the analogy with magnetism and later discoveries gives us a certain right to say:

First: 'The psyche is something outside the reach of our senses; it causes certain states in matter, which states are within the reach of our senses.'

It is of course only through movement that we can become aware of this state. Then comes the question, What is a psychological movement? Our whole life is a world of movement. We see dust and leaves blowing about in the wind; we see streams flowing and water plants swaying in it. We hear the wind and feel it; we see a little ant carrying a piece of food to its nest, we see an egg apparently unmoving, but if we have the chance of watching it long and carefully enough we see a continuous movement, which eventually results in a chicken. Which of all these movements are movements of the psyche and which are not? We need not dig too deeply into logic and metaphysics to find a definition. We will be practical and say: Only movement which has a definite motive can be a 'psychological movement'.

Secondly: Our own psyche is naturally the criterion which enables us to establish whether there is a motive or not.

Very logical people may not be satisfied with this part of our definition, but for the practical naturalist it is sufficient. Secondly we learn by experience that such movement occurs only in certain kinds of matter – namely organic; that it mostly originates in the organism itself, and is not dependent on forces outside itself. I purposely say *mostly* because there are many motivations in nature which are really dependent on outside forces and yet are psychological movements. There is the case of the seed of what we call the 'flute' reed. Like a little powder-puff in shape the seed floats on the lightest breeze like a tiny airship, but as soon as it arrives over a pond

or a marsh, the seed sinks to the ground like a bird settling on the water or damp ground. At first sight this appears to be a true psychological *motive movement* coming from within the seed, such as we very seldom find in the plant world. But on closer examination the explanation is merely this: through friction by the wind the little powder-puff, before it wrenches itself from the mother stem, receives a charge of negative electricity. The result is that all the fine hairs of the puff spring apart. As long as the hairs are spread open, the seed floats in the air; but as soon as it comes in touch with water vapour, the electricity is discharged and the puff folds up and slowly sinks to earth. By this means the plant makes certain not only that its seed shall be spread afar, but, what is of greater importance, that every seed will land on damp ground or actually in water. Here you have a number of objects which the plant achieves by utilizing natural forces outside of itself; nevertheless all these fall inside our definition as movements *with a motive* and therefore psychological.

Thirdly: Mostly – but only mostly – the movement originates in the organism itself.

The above definition will suffice for the practical naturalist. He will at times come across some puzzles, as for instance the pretended death of the *toktokkie* or the growth of a crystal; but after reflection he will find our definition still suffices.

A few words more about our classification of these motivated movements in nature and then we have finished this dry-as-dust topic and can continue with our termites. That all this has been very necessary you will see later.

I have classified it as follows:

1. Motivated movements in the plant world.

These consist of four kinds:

(*a*) Growth (for instance the turning towards the light by plants).

(*b*) Tropism. Induced by outside influences.

(*c*) Movements dependent on natural forces outside the organism.

(*d*) Movements which appear to originate from within the organism, for instance the extension of tendrils towards near objects by certain creepers; this may also be a tropism.

2. Motivated movements in the lower animal world. The most common and most important are movements which originate in the organism itself, external forces of nature are used, but in a manner differing from that of the plants. The peculiarity of these movements is that they always follow a fixed course; the organism can never modify or change its behaviour; and this fixed behaviour is as much inherited as the organs of the body.

The investigator very soon comes to the conclusion that all motivated movements are dependent on what we call memory. These predetermined inherited motivated movements we call instinct. You come across this in all its original perfection in insects; and through the whole lower animal world you find it unchanged until you come to the apes and man and then only you find a vast and striking change in motivated movements, both in quality and in quantity.

Let us return again to the psychology of instinct. I said that the memory which constitutes this instinct is hereditary in the same way that the physical organs of the organism are hereditary. The following experiment which I myself carried out will explain what I mean.

The well-known yellow South African weaver bird, there are many kinds, but any kind may be used for this experiment, plaits a wonderful little nest at the extreme tip of a flexible branch, generally over water. You often see their nests at the end of the thin drooping twigs of the graceful weeping willow, but have you ever taken the trouble of

watching to discover how the very first piece of grass is tied to the twig and what kind of knot the little bird uses? The full-grown bird is a seed eater, but the little ones are fed on worms until it is nearly time for them to leave the nest. Remember these two instinctive memories:

1. How to build the nest, and
2. How to feed the fledglings.

I hatched the eggs of the yellow weaver under canaries, for four generations. The new birds were forced to lay eggs each time without being able to build their characteristic nest. This is the most difficult part of the experiment, but it can be done. Every time these eggs were hatched under canaries, the young ones were fed on a synthetic diet and were never allowed to see a worm or an insect. Nor did they ever see a piece of grass which might be utilized for building. Then I took this fourth generation and provided them with everything which they would need in their normal environment. Remember now that for four generations they have not seen a plaited nest or tasted a worm. From personal experience the bird cannot possibly know what to do. There can be no question of individual memory. I expected at least that there would occur *some* deviation from normal behaviour, but it was not so. When the time arrived for nesting, the birds began plaiting vigorously. They made more nests than they required. This often happens in nature as a means of protection. The eggs were hatched and the young ones were fed on worms!

This experiment shows what I mean by the inherited memory of instinct.

The second characteristic of this psyche is that the individual is incapable of deviation from a certain fixed way of behaving, in other words he cannot acquire any individual causal memory. He is bound to his inherited memories. This inherited memory is in every respect a terrible tyrant. Even

when death threatens there is no escape, if escape means behaviour contrary to the inherited memory.

I will give you two examples. The black 'road-maker' ants – real ants this time, not termites – are found in many parts of South Africa. They make footpaths, hundreds of yards long at times, along which they bear all kinds of plant and grass seed to their nest. At a distance you see two streams of these ants, one apparently white, the other black. The approaching ants each carry a white seed; the retreating ants carry nothing. The ant carries the seed in its husk down into the nest. Here the husk is carefully removed. The seed is stored, and the husk is deposited outside the nest in a heap. One kind of 'road-maker' ant is a master of a wonderful natural secret which even man has not discovered. It knows how to prevent the germination of seed, even when this is placed in damp ground in the dark. I think they must whisper an incantation which bewitches the seed. The microscope can discover not the least flaw in such seed, yet if you pick some of the same seed and place it in exactly the same spot where the ant places his, it germinates within a few hours. But there, just see how one is led astray involuntarily when one is dealing with ants! To come back to our subject. These 'road-makers' are very much afraid of water. A flood is their greatest natural enemy. Do you know why? They were originally a desert ant, more or less modern emigrants to more privileged districts, therefore they have not yet learnt how to protect their subterranean nest against long continuous rains.

Deeply rooted in them therefore is the fear of this arch-enemy of their race. The only solution they have is flight – early and as far as possible.

If you dig a little furrow across their path and fill it with water you cause the greatest bewilderment amongst the ants. On both sides of the furrow there congregates an excited throng and it takes them a very, very long while to discover

that an easy solution would be to make a detour. Before they think of this, however, you place a grass stalk across the waterway to serve as a bridge and at once you will be enabled to watch very peculiar and mysterious behaviour. The ants begin to test the dangerous bridge. One by one, they try the bridge with their forelegs, stretching their bodies across it, while they cling to the bank with their back legs. They feel the bridge with their forelegs and antennae, then become aware of the water and hastily retreat to tell their companions that undoubtedly the bridge is quite unsafe. This is what happens on the bank which is on the same side as the nest, where the unladen ants congregate. On the other side of the bridge, the side farthest from the nest, the behaviour of the ants is quite different. The ants arrive here, each laden with a grass seed. Generally the seed is so heavy that the gait of the ant is very much impeded and difficult. What happens at the bridge? With apparently not the least hesitation each ant steps on to the straw with its gigantic burden. Sometimes it capsizes, but clings to the bridge with all its legs, and crosses. Always it succeeds in bringing its load to safety and hastens homewards to the nest as though nothing untoward had happened.

Here you are confronted by a riddle; the unladen ant is afraid to risk its life on the bridge; the laden ant crosses with a load which makes its passage a hundred times more dangerous. The carrying of the burden cannot lessen its awareness of the water. Now take a square piece of tin covered with earth and push it under the ants congregated on the nestward side of the bridge. When they are gathered thickly on the tin, pick this up with the ants. With a fine camel-hair brush mark as many ants as possible with a small red mark on the hinder part of the body, and then shake them on to the ground beyond the bridge. Immediately they all dash off along the path, to return shortly each carrying a grass seed,

and they cross the bridge without a qualm, as if they had been crossing bridges all their lives. After a while some of your marked ants will return from the nest, having safely deposited the seed. When they come to the bridge they stop, and nothing you can do will give one single ant the courage to cross the bridge. And so you may continue from morning till night, if you have the patience of a naturalist, until almost every ant is marked with a red spot. In the end you will have learnt two things:

First, that you will never teach the ants by their own experience that the bridge can be crossed in safety. Secondly, you will never teach the ants that if the bridge is safe for a heavily laden ant it must be, proportional to the load, so much safer for an unladen ant. They prove this for themselves hundreds of times. If you were to continue this experiment for months, the ants would be able to prove this fact thousands of times, but their behaviour never changes, until at last you will give them up as hopeless. The unladen ant will never dare to cross the bridge, but as soon as he returns with his heavy burden, he crosses without hesitation.

Can you guess why the unladen ant refuses to cross and the laden ant does not? If you have investigated the psychology of animals, the behaviour of the ants will not remain a secret for very long. The behaviour of the unladen ant which leaves the nest is determined by only one instinctive urge – to fetch food. In any case it is not a very strong urge, for it always operates in opposition to the ever-present and very great urge – the *homing instinct*, the strongest of all psychological urges, except the sexual, where this is present in individuals. Higher up the scale of animal life we call this urge 'home-sickness', *heimweh*. The ants returning with the seed are drawn by two of the strongest urges:

1. Homing instinct, and
2. Bringing the food to safety.

It is as if you had tied threads to the ants and were pulling them. The thread pulling the ant away from the nest is very weak. When the ants become aware of danger and become afraid, the thread breaks. But the returning ants are drawn by two strong threads, which even a fear of death cannot break. We see therefore that the riddle was not such a very difficult one after all.

You understand now what the psychologist means when he says that the instinctive psyche cannot deviate from the inherited formula of behaviour, and that no individual can acquire a causal memory – in other words he cannot learn by his own experience.

I also said that the psyche of inherited memories is a force which cannot be turned aside even by death if escape means behaviour which conflicts with the race memory. As an example of this I will tell you about the case of the springboks on the Springbokvlakte in Waterberg. This *vlakte* or plain is an island of open veld in the middle of the Transvaal bushveld. The springbok is highly specialized for life on the open plain, in other words all his inherited memory is of open plains. He knows how to escape the perils which threaten him there; he knows which is the best food for him there and how he can find this; he knows when and how to change his quarters. He can see and smell over great distances. On this plain there were, twenty years ago, thousands of springboks. Now they have been exterminated. Slowly but surely people have crowded there, made farms, fenced off camps, and destroyed the springboks. To the west rose the mountains and to the north lay the endless bushveld, where they would have been absolutely safe. Death lay on the one hand and safety on the other, but they could not take the step which would have saved them. Thousands of other big game, less specialized, fled into the bush and saved themselves from extinction. Often it happened that herds of springbok were

chased by hunters into the bushveld. Always they returned – sometimes the very same day – to meet death on the open plain.

There still remain two further kinds of 'soul movements' or instinctive urges in nature, the classification and peculiarities of which you must know if you hope to understand even a little about the behaviour of the termite.

3. Group movements. There are some movements in individuals of a community which are determined by some purpose of benefit to the community. We term this phenomenon the 'group psyche or soul'. You find it in the termites, ants, baboons, apes, and in all animals which live in groups or are gregarious.

Then lastly:

4. The psyche of individual memory – that is the psyche of the primate, man and the apes, baboons and monkeys.

When you live with baboons you very soon see that the difference between the psyche of the lowest baboon and the highest mammal (the dog or otter, for instance) is far greater than the difference between the psyche of the baboon and that of man.

What exactly is the difference? We know that the difference is there, but to put our meaning into words is difficult at first. A great deal of very patient work was necessary to enable me to write down in black and white of what the difference consists.

If you ask scientists what the psychological difference is between a baboon and an otter, nine out of ten will say that the baboon possesses powers of reasoning and intelligence, which the otter lacks. It would be just as clear if they said the baboon is a baboon and the otter is an otter. Neither answer takes you very far. Another scientist may say that a baboon can learn new habits more easily than an otter. This is more enlightening but does not help us a great deal.

Let us look at this race memory carefully and see what the result of it is in nature. Let us take a land bird that can fly and is very much the same in every respect as other land birds. Gradually our bird begins finding food on the beach. After millions of years he learns to catch fish in fairly deep water. As soon as this becomes a fixed habit natural selection begins to operate. The deeper the bird goes into the water, the more chance he will have of survival if he is equipped for his new life physically and psychologically. And so it goes on for another million years. The bird loses his wings, they now serve as oars; he loses his feathers, which become down; his legs become adapted for swimming – and at last we have the penguin. By the way, you will see I adhere to Darwin's theories: I never saw very much in those of De Vries. If we observe the penguin or the otter, for all that I have said applies to both, we notice several important facts. If any sudden change occurs in their environment, they are completely at sea. Let me give you an example of the otter in these conditions. Once in the Waterberg during a drought which lasted for four years and when all the streams became stagnant, you would find otters all over the veld adjacent to the big waterways. There were still pools of water, but these contained no fish or crabs. The otter is a nimble creature, and you can teach him to catch birds and other small land animals in the same way as a cat does. But he cannot teach himself to do this. Hundreds of these wild otters died in the midst of plenty. At this time I managed to get hold of a pair of newly born otters. One of these I sent to Springbokvlakte, thirty miles from the nearest running water. As he was dug out of the nest shortly after birth, he had never seen a river. A bitch reared him with her own litter. He never saw or was given food other than raw meat, birds and other land animals, and he never saw water except when it was given to him in a dish to quench his thirst.

At the same time I took a newly born baboon from the mountains to the plain and reared him with a feeding-bottle. Afterwards he was fed on food which was not his natural diet. No opportunity was given him of catching or eating a living insect. When both these animals were three years old they were taken for the first time to their own natural environments, the otter to Sterk river, whence he came originally, and the baboon to the Dubbele Mountains where his mother had been shot. Both were starved for a short while previously. Here I had a wonderful opportunity of observing the great difference in behaviour of these two creatures. The otter just hesitated for a moment or two, then plunged into the water, and within half an hour had caught a crab and a large carp and devoured them on the rocks.

The baboon, on the contrary, was completely lost. He was in the midst of a plenitude of natural food yet, although starving, he obviously knew nothing of turning over stones and catching the living insects which hide beneath them. There is no doubt he would have died of hunger if he had been left alone. When I turned up a stone for him, he retreated from the wriggling insects, and showed signs of fear and horror. With the greatest difficulty I succeeded in persuading him to taste a dead scorpion, from which I had removed the sting and the poison gland, and at last he was induced to catch a living one, with the result that he was immediately stung on the finger. He chose, amongst other things, to eat a wild mountain fruit which is deadly poison and his life perforce had to be saved. Such accidents never happen to wild baboons. They have learnt. Our tame baboon also eventually understood all these things, but he had to learn by painful experience.

We see then that nature has done two things for the baboon: she has given him a psyche which is able to acquire individual causal memories; and secondly she has done away

with his inherited race memory. The baboon is the transition point in the animal world. He has advanced so far that in about fifty per cent of cases there is no inherited orientation of the sexual instinct, the instinct which is the strongest inherited instinct of all. In man we find no inherited orientation of this instinct at all. Sexual desire may awaken, but the orientation must be learnt in both sexes. How has this extraordinary change in natural behaviour taken place? In the first place some great advantage must accrue to the race through the change. You will understand that on the whole the result of inherited memory is to bind a race tyrannically to a special environment. The penguin to the sea, the klipspringer to the mountains, the springbok to the plains. The more perfect race memory is, the more strictly confined will be the organism to his environment. This is the only result of natural selection. The affirmation or belief that selection and development in nature are striving after some ideal state of perfection is childish and false. In every case of highly specialized animals we find a loss of physical perfection. An exchange always takes place and the result is not perfect. When the penguin exchanged his wings for oars, he did not become more perfect; the long neck of the giraffe is a disadvantage in flight and distinctly unsightly. Nature is not a charitable institution. She is always inimical to life, or else there would be no natural selection. It is clear, too, that the race which is bound too closely to a certain environment is at a great disadvantage. If the environment suffers a sudden change, such a race is lost. It cannot change to a new environment and individuals cannot acquire new memories to enable them to cope with the changes in their environment.

In Africa it frequently happens that whole races are exterminated by such changes in nature, as for instance droughts, locust, or the arrival of other unknown enemies. To give a race the great advantage of being able to change its environ-

ment suddenly, natural selection must cause a change in the very psyche. No single or even repeated somatic change only can bring this about. There must be psychological change, too. The first and most important step is to wipe out the inherited or race memory. Unless this happens there can be no change in environment. Not only must the race memory be destroyed, but even the possibility of its being inherited must disappear from the psyche – or the change will be useless. Instead of race memory a psyche must be developed which enables every individual to acquire his own causal memory of his environment. It is this change in the baboons which has given them an advantage which everyone who is familiar with them will concede.

The immediate result of this change was to make the baboon a citizen of the world. He can adapt himself to any environment – that is why we find our South African baboons in most varying surroundings. You find them on the fruitful mountains of the Cape, in the big forests and river valleys of the interior, and in the waterless deserts of the Kalahari. In every environment he acquired new habits. He learnt to catch sucking lambs and tear them open in order to drink the milk in their bellies – throughout half of South Africa. In the Northern Transvaal he has not learnt this yet. In one district on Waterberg he has learnt to place a hard fruit on a rock and break it open with a stone – his first use of an implement. Nowhere in nature will you find these things happening except in the baboons and apes.

From all this investigation we find two facts which are clear as daylight. First there is a vast psychological gulf between the pysche of the baboon and the psyche of the highest mammal below the race of primates; and secondly that the psyche of man and the psyche of the baboon are exactly the same in quality. The difference is found to be only in quantity.

In the case of the baboon we are looking at the stream near its source in the mountains. In the case of man we see the same river just before it disappears into the ocean.

Man has gone farthest in this direction, and that is the reason why he has conquered the biggest and driest deserts, the Gobi and the Sahara, the highest mountains, the deepest valleys, the tropics and the frozen Poles – and yet survived. But nature demands payment for all she gives. As we have shown there is always an exchange. The baboon and man paid an exorbitant price for their new type of psyche – a price which is bound surely but slowly to bring about their natural extermination. One day, when I have finished telling you about the termites, I may tell you why I think that.

Only one more word about the psyche of the individual causal memory. The old animal psyche of race memory does not actually get destroyed, but it is paralysed by a kind of permanent inhibition. But it still remains and can be artificially stimulated into function. This, I think, is the greatest discovery I made during an observation of the wild baboon lasting over three years. There is not the least doubt to my mind that the so-called subconscious psyche of man is not a wonderful creation of natural selection which leads to ideal perfection, but is in fact only the old animal psyche in a state of inhibition; and which in abnormal circumstances is released and leads to serious psychological disorders.

We have gone a tremendous detour, but now at last we have reached the point where, with a clear conscience, we can investigate the communal psyche of the termite.

5

LUMINOSITY IN THE ANIMAL KINGDOM

THE ordinary use of light by the glow-worm and firefly is well known to dwellers in South Africa. Here in the Transvaal the fireflies at times make an amazing show. On the slopes of the Highveld they appear at times in such numbers that the river-beds stretch into the night like streams of light as far as the eye can see. I must confess at once that I do not know for certain what is the motive of this signal. In spite of long and careful observation, I never succeeded in actually seeing the result, if there was one, of the signal. It almost seems as though the insect purposely hides her motive when she becomes aware of being observed. In this respect the firefly reminds me of the pollination of one of our grasses, *Aristida*. If you ever wish to undertake heartbreaking and hopeless investigation, I advise you to try to be a witness to this pollination. I remember how I watched one whole day until after midnight at the side of the unpollinated plant. At night acetylene mine lamps were lit which cast a circle of light as clear as day for nearly a hundred yards round the plant. And then at last, when weary and exhausted I went to sleep for a couple of hours, I woke to find that the miracle had taken place while I slept – for the pollination takes place when you least expect it: an hour or two before daybreak. In the same way I spent many sleepless nights watching the firefly and never convinced myself what the motive of the signal could be. I think it is a sexual signal. If there is a doubt, it arises through the fact that the sexes are not dependent only on the light for their sexual life. There are other land

creatures which also become luminous periodically. The most wonderful, certainly the most entrancing, is the large green centipede which is found in tropical parts of Africa. Perhaps this gigantic centipede causes more fear and horror in people unused to handling such creatures than any other. For some reason – which I do not know – this monster sometimes becomes luminous. It is a rare occurrence. I have only seen it twice. The spectacle is one which the lucky beholder will never forget. If you come across the creature in the dark, while it is luminous, your first conclusion is that it must be a necklace of precious jewels. What would not a lovely lady give for a necklace like that! It is about twelve inches long – both mine were females – and while the luminosity lasts the creature, usually so nimble and quick, appears to be in a state of cataleptic paralysis. It appears as though all its energy is being used for the generation of the brilliant light. So bright is the illumination that fine print can easily be read in a dark room at a distance of two feet. What causes the light? I have no idea. A friend of mine, a chemist, examined all the organs of one of these luminous centipedes and he could find no trace of any known light-giving element; under the low power of the microscope the light appeared to come from two luminous patches near the ends of each segment of the body. The light is in continuous movement, an irregular glowing and paling which expands and contracts in concentric circles coming from an intense centre of white light. The circles of light are independent of each other. Coincident with the change in intensity there is a constant and amazing change in the colours of the circles of light. Passing outwards from the white centre, the colours appear in the following order: light yellow, light green, emerald green, dark green, blue, dark blue, red, purple, violet. The source of the light lies within the body of the insect and is irradiated through the skin. In the glow-worm the source of the light appears to be

outside the skin. You will see that there is a great unexplored field of work in connection with the signals of animals. That is why I have told you about luminosity to complete our list of signals. I like writing about the firefly, too, for the very reason that this little insect is still wrapped in intriguing mystery.

What is the motive of the light? What *is* the light? I must confess ignorance. I can tell you very well what it is *not*, but the opposite side of the balance sheet will remain blank. This happens frequently when we study animals which make use of well-known forces of nature.

The South African jelly-fish, for example, has as a means of defence a charge of electricity, with which he shocks you if he touches you under the water. Now the whole of the body of the jelly-fish is filled with water, which is a perfect conductor without insulation; it is surrounded by sea-water which is a far better conductor than the human body. In such conditions it appears impossible for the creature to generate a charge of electricity and still more impossible to direct it through human skin. The creature simply *cannot* do it – yet it does!

While we are talking of fireflies and glow-worms, I want to question one theory – very diffidently. The famous Fabre died under the firm impression that he had discovered the secret of the light. On the skin of the insect we find a white powder, which looks very much like frost. On to this the insect projects two streams of air; the light disappears in the absence of oxygen. Fabre therefore concluded that the phenomenon was nothing else than oxidation. He had no further doubts and his statement has been repeated by many writers. I would like to say this: If it *is* oxidation, then it is a form of oxidation which is found nowhere else in nature, which the cleverest chemist cannot imitate, and which would necessitate a complete revision of all our beliefs about the properties of oxygen.

Oxidation always generates heat. If it takes place very slowly – like for instance the rusting of a metal – then the heat is generated so slowly that it is not noticed – but still there is heat. If oxidation takes place rapidly, the generation of heat becomes explosive. When oxidation takes place quickly enough to cause light, there *must* be a previous and continuous generation of heat. Oxidation without this phenomenon is just as impossible as fire without light or heat. If oxygen is necessary for the firefly's light, that does not prove that the light is due to oxidation, as Fabre claimed. Take several fireflies and test them with a sensitive thermometer; you will find there is no rise in temperature due to the light. One could prove that to produce a light equal in strength to that of the firefly for one hour, the bodies of more than eighteen hundred fireflies would have to be burnt. I think Fabre's theory was wrong.

Another word about light. Some years ago a Japanese naturalist discovered that the firefly emits rays which affect a photographic plate *through* the black covering. These rays must be those which are imperceptible to the human eye. I have been unable to test this myself, or to discover whether our fireflies also emit these rays.

6

THE COMPOSITE ANIMAL

THE division 'group soul' in our classification of psychological movements is one which the human mind finds most difficult to understand. The further we depart from our own psychological characteristics, the more mystified and puzzled do we become, and the true group soul is the opposite extreme to the psyche, i.e. of the primate, which consists of uninherited, individual causal memory of the environment. The most perfect example of the group soul can be observed in our own bodies. The human body is composed of a number of organs, each connected by a visible or invisible thread to the central point, the brain. Each organ is in constant activity and has a separate purpose – at least the purpose appears to be separate and independent; but on closer observation we find that all the organs are really working for a communal purpose. The influence dominating all the organs comes from one central point. In no single organ can we find a real independent purpose. After the composite physical body of a highly developed animal like man, there is no better example of the functioning of a group soul than the termitary.

I am now entering a province which will tax your credulity to the utmost, so I will go slowly step by step, making certain of one before we take the next. I promise that I will make no statement which cannot be proved experimentally and, when the facts appear too wonderful and incredible, I will tell you the experiments in order to enable you to repeat them and perhaps even improve on them.

In everyone who carefully observes the termite, the question is bound to arise, 'Why do they continue working? What is the mainspring of this restless activity?' Restless it is

indeed. Do you know that of equally developed creatures the termite is the only one which apparently never rests or sleeps? However carefully you observe it, you will never surprise the termite at rest or asleep.

What is the aim of this ceaseless toil and struggle? In other individual animals nature has planted great irresistible urges, the sexual and parental urge, the urge to defence, the urge for food and drink. These urges constitute the psyche of the individual and dominate its movements. In the individual termite there are none of these urges to act as a driving force.

The answers to these questions really constitute the definition of a true group soul. In order to be perfectly clear I will give my line of investigation in the form of theses.

1. All the movements of the termite are controlled from without the individual. The termite possesses no vestige of free will, or power of choice. The only quality it possesses is automobility – power of moving itself. It puts itself into motion, but when this motion will take place or what will be done with it, is decided, controlled from without. Circumstances may render the termite's work useless and vain; in cases where the simplest insect individually controlled would shrink from its destiny the termite must carry on. It must follow the path along which the unseen arbiter of its fate urges it to go.

2. The whole behaviour of the termite is determined from without by an influence – we may call it a thread by which he is firmly tied to the queen's cell. This invisible influence streams from the organism of the queen alone. It is a power beyond our senses; it can penetrate all material barriers, even such as thin steel or iron plates.

3. Distance lessens the influence: it has power only between fixed limits.

4. The somatic death of the queen destroys the influence immediately. Injuries and wounds sustained by the queen

weaken the influence in proportion to the size of the injury.

5. The termitary is a separate composite animal at a certain stage of development, and lack of automobility alone differentiates it from other such animals.

6. The termite has descended from an ordinary flying solitary insect. The development of specialized groups and their amalgamation is a late occurrence in the race-history of the termite.

7. The termitary is an example of the method in which composite and highly developed animals like the mammals came into being.

8. The body of a mammal with its many vital organs can be looked upon as a community with specialized individuals grouped into organs, the whole community forming the composite animal. The higher the development of the animal, the higher the specialization of the groups.

9. This phenomenon of specialized groups of individuals being developed into different organs and becoming a composite animal can actually be observed today in nature.

The group soul, which is surely the most amazing psychological phenomenon in the natural world and gives the strongest proof that it may be possible for a psychological influence to have effect on an organism at a distance, is the result of this communal life. It is important therefore that we should observe the composite organism and try to understand it. The particular kind of termite on which I based these observations is one of the most common, in South Africa, and everyone will be able to study it.

If you make a breach in any termite's nest on the veld, it will in all likelihood be the nest of the kind of which I am speaking. In the breach you will see two kinds of insects, differing so greatly from each other that if you know nothing of termites it will take a great deal to convince you that they

had the same mother and father. One is an ordinary whitish insect with strong jaws, and two black spots which appear to be eyes. The other, under a magnifying glass, looks like a nightmarish monster. It is reddish yellow in colour but when many are massed together the red colour becomes dominant. The body ends in a massive triangular head tapering to a long black hornlike needle or syringe. Below the neck there are four almost rudimentary legs in addition to the other ordinary functioning legs. This needle or syringe is in direct communication with a large reservoir of fluid. In your wildest imagination you could not create a creature more totally cut off from the outside world. Except its two antennae, there is no trace or sign of any organ of sense. How and what the creature eats is a riddle. The only possible food would have to be a thin fluid. The ordinary food which is carried into the nest must have undergone a great change in the bodies of the other termites before this horned beast could make use of it. It is not necessary for our purpose to theorize about all the probable functions of these insects. With a fairly powerful magnifying glass you will see at once that the behaviour of these two kinds of termites in the breach is not identical. The syringe-bearers throng in increasing numbers and, with their syringes pointing outwards, quickly form a ring round the opening. If you tease one of these termites with a stiff bristle, a kind of conclusive movement passes over it, while it makes a stabbing movement with its weapon in all directions. Eventually a crystal clear drop of sticky fluid appears at the end of the syringe. This fluid contains a certain amount of stinging acid. There can be no doubt that these syringe-bearers are there to defend the nest against the enemy, relying on their terrifying appearance as well as their weapons. Apart from this they do nothing. Protected by this cordon of defenders, the other termites begin working busily. They begin to mend the breach, or to heal the wound. From the

depths of the termitary, each appears carrying a tiny grain of sand or earth in its jaws. With the help of similar rudimentary legs as those described in the syringe-bearers, the grain is turned about rapidly. Under the microscope you will find that the object of this is to coat it with a similar sticky fluid. It is then fastened to some section of the wound. It cannot fall. If you touch the newly built section, your fingers become sticky, as if you had touched some syrup. This fluid has the property of evaporating very rapidly, and as soon as evaporation has taken place the stickiness disappears.

One of my theses was that the termitary is a separate and perfect animal, which lacks only the power of moving from place to place. I will give you my proofs of this little by little, and the explanation will make clear at the same time the beginning and development of the group soul. Up to now you have learnt what happens in a wounded termitary. Let us turn our attention for a moment to a far more developed composite organism before we return to the termitary.

I take for granted that you have a general idea of the construction of your own body and how that machine works. You know that your body consists of millions of cells, through which there is constantly flowing a fluid which we term blood. The fluid consists chiefly of two separate kinds of organism, red and white corpuscles, each of which is a living cell having a life or soul of its own as well as a group soul. These corpuscles build up the body, mend wounds and attack germs. Metchnikoff's conclusions in this connection, although doubtful in certain respects, are nevertheless true in their general lines.

The attacking microbes are themselves attacked and devoured in the wound or in the natural orifices, or, if they succeed in entering, the fight is carried on in the cells and passages. Every wound swarms with defending white corpuscles. If a germ of disease enters the system there is an even

leucocytosis or increase of white corpuscles. Both growth and healing always take place from within outwards. Covering the vital organs we have the epidermis or skin, a tough impenetrable covering which shuts out light and air. The corpuscles of the blood are afraid of air and light. The growth of the body is more wonderful and mysterious than we realize. We are far too prone to consider every ordinary natural phenomenon as a kind of axiom which needs no explanation, like, for instance, the fall of an apple to the ground. Just consider for a moment the growth of the body, with particular reference to the skin. Growth always takes place from within outward. But we do not find a piece of skin being removed, a piece of an organ being built, and then a new skin being grown over the wound. The growth takes place under the skin. You would be justified in expecting either that the skin should stretch or that a new piece of the body should be grown on top of the old skin and then a new skin over that, so that if you cut into the body you would find layers of old skin. Neither of these things happen. Well, you say, of course the skin grows in the same way that the internal parts grow. It is easy to say this, but we cannot find any proof of it. We know that all growth is caused by the corpuscles in the blood-stream. But we know that these corpuscles never come in contact with the dermis or outer skin. How this outer skin grows at the same rate as the other organs we cannot explain. You know, too, that your body consists of several large organs, each of which functions independently. According to our classification each of these is a separate animal with a separate psyche. Then you have another organ which is the home of the group soul – the brain – the centre of the community which is the body.

You have learnt by this time that soul and life are identical. Every definition for soul will be equally as good for *life*, and vice versa. I have never observed any occurrence

which tended to prove that soul and life were two separate entities. They are one and the same. The only difference lies in the two names, which have been given to the same thing.

A small injury to the central point, the brain, is sufficient to cause immediate death of the whole body. The growth and life of the body can continue only with the help of the red and white corpuscles of the blood. Food is taken through a foramen, the mouth, and, after being changed or digested by certain organs, is absorbed by the corpuscles. Ninety per cent of this food is carried to different parts of the body and used as cells to make new muscle, sinews and bone. A portion of the food consists of unassimilable material, but this must be absorbed by the corpuscles with that which is assimilable, because it forms part of the assimilable material. Within their own bodies, the corpuscles separate the assimilable and unassimilable, and the waste is eventually cast from the body as excreta.

I have just said that a small injury of the brain is sufficient to cause the death of the body. Let us study some of the peculiar and mysterious aspects of the condition we call death.

We know that a living person can remain in water for ten days without any part of his skin dissolving. The channel swimmers stay in the sea for twenty-four hours and their skin is quite undamaged by this immersion. Water cannot wash away any part of the living skin, in fact the skin of a living man is as insoluble in water as india-rubber. The whole body of a living person is full of elasticity and possesses a great power of resistance to blows of blunt objects. Remember these two characteristics:

1. Insolubility of the skin.
2. The general touch-resisting powers and the elasticity of the whole living body.

The change which takes place in these two respects after

death is astounding. Have you ever seen a drowned man who has been in the water for some hours? You will remember the gruesome change. What has caused this? As soon as life ends, the epidermis becomes more and more soluble in water; and the body immediately begins to lose its elasticity and power of resistance, until at last even a child could poke a blunt object right through the body. To put it baldly, every part becomes spongy and falls into decay. The physiologist expresses all this differently, generally in long Latin or Greek words, but the meaning remains unchanged. He says: As soon as death has taken place, the more complex components break up into simpler ones. Microbes appear, to hasten the process. This does not help us to understand things more clearly, for the following reasons:

The body consists largely of dead matter. All the cell walls and the outer skin are made up of ordinary dead matter – or chemical substances. What do the corpuscles do to prevent the solubility of the skin and to protect the elasticity and structure of the body? No one knows. The presence or absence of the corpuscles makes this vast difference. You have heard doubtless of a certain mysterious phenomenon in chemistry – how the mere presence of one element can change the chemical make-up of another element. The same kind of function is played by the living corpuscles in the blood-stream. This secret, inexplicable influence, which their mere presence has on the chemical and physical character of dead matter, is the mystery of life. In the simplest living cell, such as the blood corpuscle, we find something which not only enables it to move, but which also prevents the breaking up of the cell material. Antagonistic forces of nature are always present ready to break up the cell. Here we find the beginning of the struggle for life – the attempt to frustrate the inimical forces of nature. The first purpose or urge is a tug of war between the life or soul and matter. This influence

at a distance of certain substances specially secreted by the body for this purpose is a well-known biological phenomenon.

The human body possesses a number of ductless glands, whose function it is to produce certain secretions. The mere presence of these secretions exercises a great influence on the whole physical make-up. The adrenal glands for instance produce a substance, adrenaline, which is responsible, amongst other things, for the blood pressure. The gland itself is completely isolated from the rest of the body and yet has this influence at a distance.

After this lesson in physiology and biology, we can now return to study the termitary in the light of our new knowledge. You may wonder how I can call a heap of dead earth like the termitary a living animal. Do not forget that the termitary is no more dead than the dead matter of cell walls which constitutes nine-tenths of your own body. We are ourselves no more than dead termitaries, through which circulates a living substance.

If you destroy a termitary you find firstly a tough resistant skin all around it. Under this skin you find that the whole termitary consists of cells through which a living stream constantly circulates. As you go deeper you find large passages and eventually a hollow, partly or entirely filled with more cells, which are of a different consistency from those of the actual heap. These cells no longer consist of earth and are covered within and without with a kind of mould. This mould is often used in South Africa to make yeast. If you go deep enough and observe carefully you will find at the very bottom a passage which goes right into the earth. If the termitary is an old one and placed on top of a dry kopje or hill, this passage descends to an incredible depth. It is the canal by which the termites get their water supply. They continue the shaft until at last they reach permanently moist ground. On

the farm Rietfontein in Waterberg I had the opportunity of following such a passage to a depth of more than 57 feet through earth as hard as rock in the side of a mine pit. The termites need a great deal of moisture. More than ninety per cent of their tiny bodies consist of water, and the whole termitary is always damp and filled with water vapour. Where they managed to get all this moisture in our dry districts would have remained a dark secret if someone had not discovered the existence of the deep vertical aqueduct.

7

SOMATIC DEATH

In an earlier chapter I drew attention to some of the effects on the human body of somatic death.

The final result may be expressed as follows: The chemical constituents of the cell walls or organic material are very unstable. In ordinary circumstances they tend to break down into simpler elements, or else new and more stable combinations take place. The final result is that organic matter as such disappears. The coherence of these unstable constituents is maintained by the mere presence of living moving matter in the vicinity of the cell walls. I used the example, for a special purpose, of the common phenomenon which occurs after death, the solubility of the human skin in water, and I emphasized the fact that although the living elements in the blood-stream, which heal the skin and keep it healthy, do not actually come into contact with the outer skin, yet their mere presence in the vicinity is sufficient to maintain the stability of the unstable components. In other words, the presence of these living elements safeguards the skin against its ever-present tendency towards dissolution. This is the first function of what we call life or soul.

One can always tell by superficial examination whether a termitary is alive or dead. In general the process of dissolution is not only analogous to the dissolution which takes place in the human body, but it is also similar. We find exactly the same appearance of undisguised lifelessness; there is the same change in smell, not the same smell, ascribable to the same causes, namely the dissolution of chemical constituents; there is the same immediate loss of the defensive

toughness of the skin. The innermost cell-structure falls to pieces, only dust and ashes remain.

The similarity of the two phenomena becomes even more convincing if you examine the termitary in detail. Look at the skin. The covering layer of an old termitary in dry seasons is thick and impenetrable, hard as cement. After long rain it becomes softer, in the same way that human skin becomes softer after long immersion in water. The living stream of termites constantly circulating through the termitary never comes into contact with the outer skin. The termites never renew the skin from the outside. Sometimes you see patches of renewal. The growth or healing, as the case may be, always occurs from within outwards, as in the human skin. But the construction of new patches is a peculiar phenomenon, with a particular purpose. As far as the skin is concerned in an old full-grown termitary, you will never observe the termites doing anything to keep it in condition. Such an old termitary is exposed year after year to torrents of rain, terrible droughts, scorching heat, frost, hail and wind, yet the skin remains undamaged. In cases of actual trauma, through hail for instance, healing takes place by the functioning of the two little creatures in the blood-stream – I mean the two kinds of termite. The living skin in general appears to be insoluble in water. Even during continuous rain you will not find the least portion of the living skin washed away. I am speaking generally, as of course we do occasionally find exceptions to every rule. For instance, we sometimes find various forms of abnormal growth, real diseases which expose the whole structure to danger. The termites are in these cases just as stupid as the blood-stream in a human may be. Sometimes the reason is obvious. You can encourage abnormal growth artificially by stimulation and other influences both in the human and in the termitary. A common ab-

normality is the growth of a long narrow tower which is constantly destroyed by wind and bad weather. This is an abnormal deviation from the usual pointed summit, which is found on termitaries amongst trees. The base of the tower is often so small that it is impossible for it to carry the superstructure. Yet every time the tower falls over it is built up anew. This is not only great waste of energy, but the abnormality often becomes a danger to the whole community.

What constitutes the difference in quality between the skin of a dead termitary and that of a living one? What keeps the outer layer whole and healthy as long as the living stream continues moving within? What causes the cell walls to retain their structure intact, and what causes them to fall apart as soon as the termites die? There appears to be only one theory which conforms to modern scientific knowledge: there must be some kind of power projected from the living stream which influences the chemical constituents of organic bodies. This functions in the termitary as in the human body.

I am trying my utmost to prove that the termitary must be looked upon, not as a heap of dead earth, but as a separate animal at a certain stage of development. You must take my word for it that all this is very important and necessary if we are to get even a faint inkling of the perfect group soul and its characteristics. To be sure that we are quite clear in our minds, let us tabulate the similarities between our own physical body and the termitary:

1. We have just seen that both possess some mysterious power which exercises an influence on the whole structure and is the cause of its stability.

2. Both the human body and the termitary consist of a structure of cells covered with a thick skin. An inhabitant of Mars who had learnt enough of our earth to divide matter into organic and inorganic would not hesitate for one

moment to classify a piece of termitary as organic. The only difference would be that, for a piece of human body, he would need a miscroscope to study the structure, whereas in a termite he could see it with the naked eye.

3. Moving through the cell structure under the skin we find a living stream consisting of two kinds of organisms which both in man and the termite have the same functions. The white blood corpuscles quickly form a defensive circle round a wound. They are there for apparently one purpose only, to prevent the invasion of strange hostile organisms. The other, or red, blood corpuscles busy themselves with repairing the injury. From the innermost part of the body these latter bear material for new cells which eventually are covered with new skin.

If you make a wound in a termitary, the living stream is seen at once. The red syringe bearers form a circle of defence round the wound. Their only function is to prevent the entry of enemies by their fearful appearance or by actual defence. For purposes of defence they secrete a clear, sticky, stinging acid. The other termites of the living stream at once begin repairing the wound. They carry material from the depths of the termitary to build up the new cell structure, which eventually is covered with new skin.

4. The human body takes food through a foramen – the mouth. The food is carried to certain organs where it undergoes a chemical change; afterwards it is taken up by the blood-stream and utilized by the red corpuscles for building purposes.

In the termitary, food is taken through several foramina and roughly masticated. It is then carried to different centres, where a certain kind of termite transforms it chemically; it then enters the living stream and is used as food for the different members of the community and for building purposes. With a magnifying glass you can observe how each

termite uses a drop of fluid from his own body to cover each minute grain which is used for building. This fluid holds the structure together. Most of the water used is carried up the vertical shaft leading from subterranean sources of moisture.

I wish to digress here in order to discuss normal and abnormal growth from another angle.

Physical growth is the most perfect example in nature of the psyche of inherited memory. It always appears very wonderful and inexplicable. We humans use our own consciousness as a criterion for classification. Eventually we discover that this consciousness can never be a criterion for psychological processes different from our own. We are inclined, for instance, to be amazed at the abnormal functioning of the subconscious mind. When we discover, however, that the subconscious mind is no more than the rudimentary animal psyche still present in man, and that all the wonders which abnormal functioning bring forth are merely usual everyday occurrences in lower animals, we need to be less mystified. In the same way we are amazed at our own physical growth. But when we study similar phenomena in nature; when we begin classifying our knowledge, we are forced to surrender our false criterion. We tend to believe that the psyche which directs human growth is something far beyond our own comprehension. This power we think does miracles which we could not do, and it appears to have some purpose far beyond our own understanding. Then, however, we begin to discover that the psyche which directs physical growth is in some respects more stupid and more ignorant than the psyche of a child. Even the 'roadmaker' ant which we observed a short while ago, which would take years to learn that twice two always makes four, is a genius compared to this psyche. The psyche of physical growth comes lowest in the scale when 'Learn by experience' is our rule of measure.

If you take reasoning powers as your measure, this psyche comes even lower.

Of course when you realize that the same psyche which will from its own experience never learn that two and two make four, can, beginning with a single cell, build up an elephant or a person, or an oak tree cell by cell, then you begin getting a little muddled. That is because you use different measures.

If you were to discover that in every elephant, every human, every oak tree, there were parts which were built wrongly in a most stupid fashion; if you were to find elephants with five legs, with deformed jaws, with regular but abnormal cell structures which form a danger to the whole body; if you were to discover that abnormal growth is often persevered in, in spite of constant destruction through the inherent weakness of structure – just as we saw in the termites with their little tower – then you would become aware of the fact that one measure cannot be used for classification.

You will come to another important conclusion. Every psychologist who studies the group soul in nature seeks an answer to the question: Is there some powerful group soul above and beyond nature which dominates all natural phenomena and directs them to some goal? It appears a hopeless task to seek an answer in nature. Every truthful naturalist, who is not led astray by his own hopes and longings, will always doubt his ability to give a truthful answer. It is possible that we see only a small arc of a gigantic circle, that the means and ways of the universal soul lie far beyond our human understanding.

It is often said that the purpose of life is natural development, it being taken for granted that the development of living creatures leads to a state of absolute perfection, not relative perfection. All that development does, however, is to equip the organism to withstand the enemies that assail it in

a special environment. For every new weapon it receives, it must lay down an old one. Man who has developed the furthest psychologically, has paid the dearest for his psyche of individual causal memory. We have seen that the psyche which directs growth possesses no vestige of the powers of learning by experience, of reasoning, of intelligence, as we call it. When we make our own deepest feelings the arbiter, we are dismayed. For we seek in vain in nature for love, sympathy, pity, justice, altruism, protection of the innocent and weak. From the very beginnings of life we hear a chorus of anguish. Pain is a condition of existence. Escape from pain is the purpose in all striving.

And Nature? Pitiless cruelty, torment, and destruction of the weak and innocent. The thief, the assassin, the blood-stained robber, these are her favourites, these are the psychological types which are the triumphant victors of the strife.

The psyche, which we see faint and barely recognizable in the higher mammals, attaining its highest pinnacle in man, seems to be an exception to the great principles which dominate the universe. So the hope arises there is some purpose in nature, whose guiding principle is a psyche similar but infinitely more developed than the soul of the primate. If this is so, we seek in vain for evidence in our natural surroundings. We are as little able to comprehend such an exalted psyche as the termite can comprehend man, who orders his own aims and purposes throughout life.

If Nature possesses a universal psyche, it is one far above the common and most impelling feelings of the human psyche. She certainly has never wept in sympathy, nor stretched a hand protectively over even the most beautiful or innocent of her creatures.

8

THE DEVELOPMENT OF THE COMPOSITE ANIMAL

I HAVE taken great pains to prove the termitary is a separate and composite animal in exactly the same way that a man is a separate composite animal. Only the power of locomotion is absent. We must not forget, however, that there are other animals who have not the power of movement.

All this may remind you of the mountain in labour, which eventually produced a very small mouse. The facts I have given, however, are as strictly true as any other established biological phenomenon, and it is necessary to accept them if you wish to understand the life history of the termite.

If you make a wound in the round termitary made by *Eutermes* later called *Trinervitermes* – a small round vertical hole with a walking stick, for instance, and then isolate the wound with a sharp circular cut through the skin, the termites begin as usual to repair the wound. But what you have done causes in many cases a curious reflex. The termites begin abnormal building. Instead of repairing the cells and passages and growing a new skin over this, they build a tower. I believe the stimulus is the entry of sunlight. If the base is too small, the tower topples over again and again as soon as it reaches a certain height, and just as often the termites reconstruct it. The tower is not only unnecessary to the termitary, but actually a disadvantage.

It is a disturbing influence which throws the normal course of life of the organism into disorder. It is analogous to the growth of a cancer.

Catch a pair of our common house lizards and tame them.

With a lancet make two or three longitudinal cuts in the tail. In some cases you will initiate a curious reflex and an abnormal growth will begin. Instead of merely repairing the wound, a new tail is grown. If you amputate the new tail, you may find a double tail sprouting. In this way you can – if all goes well – manufacture a lizard with seven tails. In the same way we can manufacture a termitary with seven towers, to the great disadvantage of the whole community. We cannot make a lizard's tail; nor can we make a tower with the same materials and in the same way as the termite. But we would be far too clever to build in such a faulty, unnecessary fashion.

I will not try to bring any further proofs of the similarity between the termitary and other animals, but if this theory is borne in mind, constant proof will be forthcoming when the termite is studied. The insects themselves should always be thought of a blood-stream and organs of a single animal.

If the highly developed, highly specialized animals originally developed from communities like the termite, one should be able to find instances of such symbiosis, which is more than mere partnership, low down in the scale of organic life. There are many such instances, which justify us in believing that organisms of several kinds can result in a successful amalgamation. Of this nature is the union between fungus and alga to form a lichen, which differs enormously from both original ones. But the object and actual results of the process are much more clearly seen when we meet it fairly high in the animal kingdom. In the sea around the African coast there can be found a hundred kinds of a certain species of marine creature. Its scientific name is *Hydromedusa*, and there is a related species known as *Siphonophora*. We will observe *Siphonophora*. There is no other animal of its size in the ocean which can boast of so large a bibliography. Ernst Hackel and other famous naturalists

spent years studying, describing and classifying them. The great peculiarity of these creatures is that every full-grown specimen is a composite animal composed of hundreds of individuals. The single individual is born by a budding process from the generative group of the composite animal. These newly born individuals swim round freely and are able to continue life singly and reproduce themselves. Each is a perfect marine creature with mouth, stomach, swimming apparatus and sexual organs. If by chance a group of *Siphonophora* happens to meet, they cling to each other. In some species organic union takes place immediately, in others something less than this. But apart from this small difference the final result is the same. Immediately after the union the single individuals undergo a curious change. One group forms a complicated swimming apparatus; another group becomes the stomach and digestive system; and yet another group develops into the sexual organs of the composite animal. One group even takes on hepatic functions and becomes the liver. Each individual of such a group loses all its separate organic functions. Those of the stomach group, for instance, forget they ever sought food or had a sexual life of their own. The new organism is a perfect whole animal. Were you to see it in its perfect stage you would not dream that it had been formed in this way from separate individuals. Yet one can break it up again! One can tear apart each individual until the whole animal has been disorganized. One might suppose death would be the result, but not at all. Each little part begins to stir in the water. Slowly it repairs its lost organs and functions until at last it once again is a perfect individual, as different from the composite *Siphonophora* as the camel from the whale.

One can repeat this process innumerable times without apparently injuring either the individual or the composite creature.

In such a way our termitary has been formed; in the same way the individuals have undergone wonderful changes in order to form group organs. In every termitary there is a brain, a stomach, a liver and sexual organs which ensure the propagation of the race. They have legs and arms for gathering food; they have a mouth. If natural selection continues to operate, the final result may be a termitary which moves slowly over the veld. There are hundreds of facts, biological and psychological, in nature which prove all highly developed animals have been formed from separate organisms. Once I collected all the facts and classified them, hoping to startle the scientific world. Unfortunately my tower collapsed, not because it was wrongly built, but because other naturalists had already become aware of all this. Claude Bernard in his opening address to the French Academy (1869), Dr Durand de Gos, in his *Electrodynamique Vitale* (1855) and *Variétés Philosophiques* (1857), tried to show that the vital organs of man were separate animals.

In our own time Jean Finot in his optimistic demonstration on Life and Death wrote: 'The teaching that the human organism is composed of separate animals, each with a separate nervous system, will, we hope, find more and more proof in the scientific investigation of our time.'

Another fact one should constantly remember is that, if there is the least grain of truth in this theory of development, then just as certainly the termite was originally a perfect flying individual insect, of which the queen and king are the prototypes. The union of these individuals and the wonderful changes which resulted from it is a late development in the history of the race. If the blind, wingless, sexless soldiers and workers are not a degeneration of the perfect king and queen type, then the opposite conclusion will have to be accepted: the perfect king and queen must be a development from one or other of the sexless types, and that cannot be the case.

There are other biological facts which indicate that the imperfect types are the result of degenerative change of the perfect insect. The rudiments of wing buds and of sexual organs in the sexless types show clearly the way development, or rather degeneration, has gone.

9

THE BIRTH OF THE TERMITE COMMUNITY

UP to the present we have observed the termites and the termitary from without. We will now study the termitary and the growth and life history of the termites from within the nest. Every step will prove a surprise; we will see many things which appear incredible. The termite differs in every respect from all other insects. Morphologically there is little in nature which reminds us of the termite. Their ontological development is a constant surprise; phylogenetically one must look in the ocean for an analogous circle of development. The entomologist who made the acquaintance of the termite for the first time, would be justified in thinking it to be an immigrant from a different planet.

To mention one thing only – the wings. Where can one find in nature an organism which during its own lifetime will yield up the mightiest of all weapons in the struggle for life – its wings? This abandonment of wings is an example of the surprises with which the termite constantly provides us.

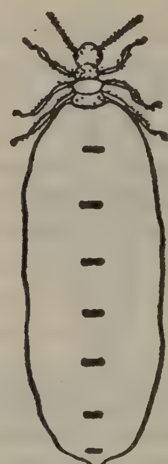
I give some illustrations of the different inmates of a Transvaal termitary. One can scarcely believe that they are the children of one father and mother. We have seen how the kings and queens leave the nest in swarms; how they *must* fly to unlock their sexual life; how the queen sends a signal; how both sexes discard their wings as soon as they reach the ground after their one and only flight. The development of the wings is very interesting. In the sexual type one can see the wing-buds quite early in life. When the insect has shed its skin for the last time and is full-grown, the wings begin to

grow from these buds with a kind of hinge which allows for the greatest possible range of movements. It is from this hinge that the insect breaks its wings with a lightning-like movement. She takes hold of the wing-buds with the nearest pair of legs, which appear to be specially adapted for this purpose, shifts them along the bud until they reach the hinge, and detaches the wings.

(Trinervitermes *magnified.) Etiolated, newly hatched termite.* Colour: *White. All classes and both sexes are found. Sex organs rudimentary, disappearing as development proceeds. Entirely blind. In some individuals rudimentary pigmented spots are found in place of eyes. These, too, disappear. In others, rudimentary wing buds appear, which never develop.*

(Trinervitermes *magnified.) King and Queen at time of flight. Perfect insects with fully developed eyes, wings and sex organs.* Colour: *Dark brown, with red marking. Highly pigmented.* Functions: *1. Reproduction. 2. Analogous to motor and sensory centres of brain in higher animals.*

When they have been shed, one can find no wound to indicate the spot of attachment, as one might expect. There must be some organic union, there must be some attachment to the central system which enables the wings to be set into motion. But there is no sign of this immediately after the



(Bellicosus *magnified.) Queen. Beginning of second stage of development.* Functions: *Female element in reproduction. Sensory and motor centre of 'brain'. As in the higher animals, the female element of the termitary undergoes periodical metamorphosis and has a far greater ontogenetic development than the male.*

wings are detached. How so complicated an organ, which is so powerful and which is under complete control of the insect, can give so little evidence of organic union with the body remains a mystery. One moment the insect is flying, a moment later the wings are detached, yet one finds no evidence of a lesion.

Another point of interest. The insect appears to be able to discard the wings by a voluntary movement of the wing

itself. Before flight has taken place, she will struggle to free herself if she is held by the wings, without the wings becoming detached. If, however, she has experienced the sensation of flight, even *one* movement of the wings appears to be sufficient to satisfy the instinct, then she will discard the wings in one's hand. The observer must understand that it is absolutely necessary for her future life that she shall at least experience the impression of flight. If she has not this, she simply dies. Then she will never become a queen, her sexual life is ended. Sometimes even the struggle for freedom as her wings are held is sufficient to satisfy the instinct. Rapid and continuous movement of the wings while the insect remains stationary on a twig without actual flight through the air, also appears to satisfy occasionally. But these occurrences are more in the nature of exceptions. As a rule, there is complete

(Bellicosus *magnified.) Queen substitute. Similar to Queen or King type, except that the wings do not develop.* Function: *Sometimes used temporarily as substitute for king or queen. Both sexes found.*

frustration sexually if the insect has not flown and discarded her wings.

The king and queen look exactly alike and cannot be distinguished apart with the naked eye. They are the only perfectly formed insects in the termitary. They have fully

developed eyes and although they were born and reared in darkness, they are highly pigmented. Black, brown and red colourings are found, which never appear in their children, except of course the future kings and queens.

The sexual organs are fully developed. Any natural means of defence is suprisingly lacking. There is probably no insect in our land which has so many natural enemies. One finds the true ant, not the termite, walking round boldly in the daylight, for only reptiles, such as frogs and lizards, which have no sense of taste, try to eat them. Their defence consists of an acid which is secreted for the purpose, and also an indigestible outer covering. So effective apparently are these methods of defence that we find certain beetles taking on the form of large ants so successfully that most animals are deceived by them. The unfortunate termite, on the other hand, is eaten greedily by all other animals. It is a remarkable lesson in nature study to watch the flight of the termites in uninhabited parts of Central Africa. Within a few minutes the surface of the earth is seething with living creatures coming to the feast. Out of the earth crawl frogs, toads, snakes, lizards and other reptiles. From where they receive the news I cannot tell. Even the tortoise appears. Other insects, crickets, beetles, centipedes, spiders, scorpions swarm in the grass. In the water, just below the surface, one sees hundreds of fish and turtles. Out of the bushes slink jackals, cats, meercats, apes and monkeys. There is a temporary truce, except as regards the unfortunate flying termites. They appear to be going to fly merely to die. One begins to understand why nature produces them in such millions, notwithstanding the fact that each pair may be the origin of millions more. Every pair is necessary, because the slaughter is immense. One realizes now why the royal pair are in such a tremendous hurry after they have flown and discarded their wings. The only method of defence the flying termites make use of is flight

after dusk. In this way they escape at least the birds which fly by day. But even this may not always happen. Sometimes the flight begins too early and in the twilight hundreds of hawks gather. The night hawks, owls and other night birds continue the feast into the darkest hours of the night.

One realizes that in this case there has been a displacement of the natural means of defence. What the individual king and queen have lost as regards natural means of defence is compensated for by the defences of the composite animal, the termitary. As soon as the community is formed, the termites never again appear in the daylight, except when injury necessitates this, and even then not in great numbers. However far they may have to go in search of food, and sometimes it may be hundreds of yards, they make underground passages in all directions, and the food itself is temporarily covered with cells and earthwork, making it unnecessary for any individual to appear in the open.

The same thing occurs with all other psychological characteristics and urges – they are shifted from the individual to the community. The individual termite is without feeling. For him there is no more pain. The injury of a group of termites, however, is felt as pain by the community. The same thing occurs in the human body. The liver is incapable of feeling an injury. It is the human being, the composite animal, which becomes aware of the injury to the liver, as pain.

Neither does the individual termite feel hunger or thirst. If there is a famine, or if water begins getting scarce, the suffering as such is felt only in the queen's chamber.

The mightiest urge of all, the sexual urge, does not exist in the individual. It has been set free from this irksome tie. The only vestige of self-government which appears to exist amongst the termites are the food, wound and danger signals which are sent out by the soldiers and answered by the workers. But this is no proof that the individual termite pos-

sesses a separate psyche. Apart from the power of locomotion, there is no vestige of this psyche. All actual motivations are directed by signals from the queen's chamber.

These signals cease immediately the queen is destroyed and all directed activity ceases, even in the outlying sections of the termitary and even when these sections have been completely isolated over a long period by a metal plate. This seems proof that the group movements, too, are directed by the queen, the brain of the termitary. The king and queen, deep in the absolute darkness of their chamber, bear in their persons two widely diverse functions, the mental and the sexual. The palace chamber is analogous to the skull in higher animals. Even the substance of the queen's body is reminiscent of the brain of mammals. All that is entirely lacking are the nerves which play such an important role in the physical economy of the more highly developed animals.

Having come to the conclusion that the termitary is a composite animal, the observer expects to find some trace at least of structures corresponding to nerves. A little consideration will enlighten one as to the reason why nothing of the kind is found. The most important function in man, for instance, of the nerves, is that of initiating and controlling movement and to carry impressions from the sense organs to the brain. On the other hand there are innumerable movements and functions in the human body which are directed and influenced by the brain without being actually linked up by nerves. I mentioned before this influence-at-a-distance which is found all over the body. The work and movements of the blood corpuscles, for instance, are set into being by an influence which is not material; so too are the special functions of the vital organs. The influence which streams from the queen is something intangible and similar to the

influence-at-a-distance which directs so many functions in highly developed animals.

In a later chapter I will show how this mysterious influence has the power of penetrating all ordinary materials. For instance, it penetrates quite easily the thickest obtainable galvanized iron plates. Distance, however, lessens the power of the queen's influence. One may imagine Nature addressing the queen thus, after her short flight:

'Beloved, you are going to suffer a great loss. Instead of living in this glowing sunlight, you are going to spend your days in absolute darkness. Instead of the citizenship of the wide veld, instead of the freedom of the air, of mountains, trees and plains, you are going to spend your days as a prisoner in a narrow vault, in whose confines you will be unable to make the least movement. The annual return of the love season, the search for your beloved and the happy finding of your home and all the happiness bound up in this periodical stirring of the soul, of all this you are to be deprived. But in place of all this, you yourself will become a far more important and wonderful being. Although you will apparently be an immobile shapeless mass buried in a living grave, you will actually be a sensitive mainspring. You will become the feeling, the thinking, the seeing of a life a thousand times greater and more important than yours could ever have become. Above all, I will give you protection. The million dangers, the million enemies which threatened your life on every hand, will in your new life fling themselves in vain against your armour.'

It was this need for protection which caused the development of the termitary. As individuals the queen and her subjects are the most threatened of all insects. As individuals, in an unprotected environment, the race would never have survived. As a composite animal, the termitary is very nearly perfectly protected. External wounds, destructive attacks

which destroy the whole visible form of the termitary, do not touch its real life, which goes on as usual as though nothing untoward has happened. The wounds are merely repaired. The queen herself, as brain of the organism, is as well protected as the human brain in its skull. There are very few enemies which ever prove a real danger to the queen. One of the largest is the ant-eater; some of the most insidious are groups of beetles, which at times completely devastate a weakened termitary. This latter instance is analogous in every respect to the attack on the human body by pathological organisms. The termitary becomes diseased and dies.

Has the queen paid too dearly for protection? Nature answers this question in a different way from that in which we, or the queen, would.

'What matters it to me how much or how little is paid for the privilege of my protection? How much happiness is lost and how much misery the new life entails is of no importance. What do I care for the individual? The race is safe, rejoicing, inexterminable. The individual must always pay, and no price is too high.'

One realizes why development has taken this peculiar course, why at all costs the queen must remain immobile, why she has been imprisoned in a cell and has lost all power of locomotion. If she is the brain of the organism, that makes it all the more necessary for her to remain stationary in one place. The duplicate functions of the queen, mental and sexual, make matters more complicated. Movement appears to be an integral part of all sexual functions in nature. There seems to be a definite conflict here, but the development of the termitary has solved the problem. I shall not enlarge on this subject here. The student of nature will be aware of what happens, and even the uninitiated will find the solution if he compares this duplication of function in the termites with the same less developed complex in the bee queen. In the

latter the sexual functions are the most important and the result is that the danger of the queen on her wedding flight becomes a danger to the whole hive. The termite queen is never again exposed to such danger, once the community is formed and she has been rendered immobile.

The human observer who watched the flight of the queen, who saw the glad meeting of the two sexes, who perhaps even lent a little human aid gives a sigh of relief when eventually the threatened pair find shelter in the protective lap of Mother Earth. Now at last they must be safe. Alas! not yet. There is another great danger which threatens the birth of the new community. In our land it is a merciless enemy – we call it Drought. The termites must have water, more water, and still more water. As ninety per cent of their bodies consists of water the greatest part of their labour is concerned with the finding and carrying of water, on which the termitary is just as dependent as the warm-blooded animals are. The king and queen must find water immediately. They obtain this from damp earth. That is why the flight occurs only after heavy rains – this at least they expect from nature. Sometimes, however, they make a mistake. The first duty of the royal pair is to manufacture an organ for hatching out and feeding the first workers and soldiers. For this purpose a plentiful supply of water is necessary. If the water supply gives out during this initial period, all is finished; it means death to them and to the composite animal. Both king and queen work incessantly, making passages in the direction of moist earth. These generally descend perpendicularly and are the beginnings of the vertical aqueduct – at least in dry districts. At intervals in these first passages they make, or perhaps find, hollows in the earth and here they make their first termite gardens. Enthusiastic observers of the real ant have called them gardens, so we will continue using the term. They resemble very much our own agricultural efforts.

First the ground is carefully prepared. The fertilizer consists of finely chewed, partially digested vegetable substance, mostly dry wood and grass stalks. Then it is irrigated with water, much water, until the ground is saturated. Both king and queen labour incessantly; they do not rest for a second, nor do they sleep day or night. It is the last time, however, that they will ever be expected to work. The functions which they will fulfil in future can hardly be called work. At last the first garden is ready, deep in a hollow of one of the passages. No ray of light must ever fall upon it, everything is done in inky darkness. This first garden consists of a pat of cell structure and earth-work, and when it is well saturated, the two termites proceed to plant the seeds of a peculiar fungus, which is to play an enormous role in the future life history of the termitary and as such deserves our careful attention. I have said the termites plant the seed. I cannot, however, prove this to be a fact, but that is what appears to take place. They walk about on the damp garden and in the shortest possible time necessary for germination and development, the fungus springs up, in the form of a white mould. I have found the hyphae and spores of the fungus on the jaws and legs of flying termites immediately after they have left the termitary. It appears as though they purposely carry the seed to plant in the new nest. One also finds spores on termites which have nothing to do with the gardens. In the neighbourhood of large termitaries one finds the spores in great numbers in the underground hollows and passages. They are spread by water, by wind, by worms and by insects. It is possible, therefore, that the spores might show themselves on the specially prepared ground, without the assistance of the termite. The termites, however, do far more incredible things than the planting of these spores would be. So they will take it for granted that they do carry the spores and that the planting of the gardens is intentional.

Whether they do actually plant seed or not, there is certainly no question about the fertilization and irrigation of the gardens. The passage which leads to the water is constantly being deepened. While the damp earth is being excavated, the moisture is stored in the bodies of the two insects. The garden is irrigated with drops of a clear shining liquid, the same in all respects as that which is used for many other purposes later on by all the groups.

In this early garden, the queen lays her first eggs. At this stage she is still able to run about quickly and work actively. In the meantime wonderful things are happening to the fungus garden. The two insects do something to the mycelium of the plant which retards growth and development and at the same time the temperature of the garden begins to rise astoundingly.

The origin of this rise in temperature seems at first inexplicable. It cannot come from the termites, for their bodies are always at the same temperature as that of their environment. It comes from the garden, which functions as an incubator and is responsible later for maintaining the heat of the composite animal. The normal temperature of the termitary taken in the queen's cell is from four to six degrees Fahrenheit higher than the normal temperature of a human being. There is little doubt that most of this heat is generated by the fungus-beds. It is well known that in all fungi rise of temperature takes place when the spores ripen. In the gardens of the termitary the temperature is kept raised to a certain degree by something the termite does to the plant which retards growth and development at the very stage when the fungi generate most heat. The garden, however, is more than incubator and nursery. The production of heat is a very important function, certainly, but in addition to this the garden becomes the stomach and liver of the composite animal.

By constant and rapid metabolism not only nutriment, but

also digestive juices are assembled in the plant. Under the microscope and chemically one can find oil, protoplasm, glycogen, carbohydrates, proteid crystals, gum, alkaloids, and different enzymes, similar to those in the human body, which break up complicated sugars into dextrose and levulose, which reduce ordinary sugar to alcohol and carbon. The only substance we find no trace of is starch.

The circle or digestion takes place in this way: The workers and the king and queen in their first stages are the only termites in the nest which can masticate wood, grass-stalks and other coarse vegetable matter, and partially digest it. No other group in the termitary is able to absorb or digest anything but fluid. When the king and queen in their first stage, or the workers, have partially digested the food, it goes to the stomach and liver – the so-called gardens. Here it is further digested and changed by the fungi and the digestive juices I have mentioned. It happens in just the same way as in the human body. When the stomach and liver have prepared the food, it is taken up by the workers and soldiers in liquid form and becomes part of the whole circulation.

More than half this predigested food is used for building purposes. When one touches a newly built tower, one's fingers become sticky. With a magnifying glass one can see how each worker rolls the tiny grain in its jaws, coating it with the sticky fluid before placing it in position. This is the fluid which is obtained from the gardens. The water necessary for the production of this fluid is being constantly supplied to the gardens by a stream of workers, whose sole function apears to be this and the sowing of seed. If a vertical aqueduct is present, one finds a hollow every two or three feet, in which a small garden is cultivated. During severe droughts, water is constantly carried to the deepest gardens and the fungi there are kept alive. The great advantage of having little fungus beds so near to the water is obvious, as it

spares the termites much labour. From these gardens the seed is carried to new ones, or to replant those which were killed by drought. These smaller gardens are never used for any other purpose; you will never find them used as nurseries, as is the case with the large gardens.

Another function of the fungus gardens appears to be the isolation of colour. A dark-red colouring material can be obtained from them. It appears, therefore, that the termites find the red colouring matter of their bodies prepared for them by the gardens. The babies are entirely colourless, as one would expect from insects born in utter darkness. One would expect that they would never become coloured in the absence of light, and as they continue living in darkness it is difficult to explain the presence of all the brilliant tints. These, however, come from the gardens. The babies are white as milk until they are fed on the fungus fluid. Then only do we find their bodies assuming the blood-red colour of the adults.

10

PAIN AND TRAVAIL IN NATURE

WE are now going to observe the conjugal behaviour of the king and queen in more detail, and will see three phenomena which are very wonderful. The word wonderful does not fit into science, for from one point of view every natural occurrence is as wonderful as another. But we are justified in using the term when we meet a phenomenon which is such an exception to the ordinary rules of nature that it appears to be a miracle. The early behaviour of the king and queen is a phenomenon of this kind. It reminds one of the fairy-godmother who waved her wand and turned the pumpkin into a coach and the mice into prancing steeds. The hidden meaning of what I am about to describe has escaped experienced observers. The naturalist Grassi studied these things in very favourable circumstances, but he did not fathom their meaning.

Much depends on the particular aspect in which the observer is interested. If one is interested in behaviourism, and has some knowledge of it, one sees much the entomologist overlooks. His powers of observation are trained to notice form; he is interested in naming and classifying; to him the dead insect is often of more worth than the living one. This does not mean that his work is of less importance; it may be of greater value than pure psychological investigation; and is far more difficult because less interesting. If, however, these things escape the experienced entomologist, it becomes necessary for us to take particular care lest we miss them too.

Up to the moment when the first garden has been made and planted and the first eggs are laid, the two insects, the king and queen, ordinary four-winged neuropterous insects, have been busy building their home, laying eggs like thousands of other insects around them. They have laid aside their wings, it is true, but they continue to behave like true winged insects. Then, however, strange things begin happening, so strange that we can hardly believe they actually occur.

While the queen is laying her eggs our searchlight disturbs her less than at any other time. It seems clear that her important work occupies her attention so deeply that even a cataclysm as the sudden flashing of an electric torch does not frighten her. She makes curious preparations. For a long while she stands on the place where the eggs are to be deposited, before she begins laying. Her body is in constant movement. The antennae sweep in circles and her jaws move ceaselessly. Occasionally she lifts the hinder part of her body in just the same way as she did when she was sending her first signal to her mate. Two or three times before the eggs actually are laid, she turns round and looks at the ground as if she expects to find something there. With the actual laying of the eggs the bodily contractions increase tremendously. When the first batch is laid, she turns round once more and examines them long and carefully. She touches them gently with her jaws and front legs, and then she lies motionless beside them for a time. What does it all mean? We are here observing one of those wonders which I promised, and which is found in no other winged insect, nor in any other insect of similar development. Unless one has witnessed a similar occurrence in an animal a little higher in the scale of life, one cannot realize the significance of this behaviour. Actually we have witnessed the first appearance of a complex which plays a mighty role in the decadent and unnatural condition of the human race today. We are seeing the first evidence in nature

of birth pangs. We think this cannot be the case in a winged insect. Surely it must be impossible. How can one tell that the queen's behaviour is due to pain.

One knows what usually happens in insects. The female builds a home, fills it with food, lays her eggs as easily and carelessly as if she were eating, drinking or cleaning her antennae. The male never appears on the scene. After the honeymoon his part of the work is done. The female's work also concludes with the building of the house and the laying of the eggs. She never sees her babies. She would not recognize them if she did, for how could she, a beautiful flying creature, have given birth to these odd little grubs, or wriggling worms?

Another thing. One has never seen a real insect baby. One expects it to be a caterpillar, then a cocoon, from which eventually comes the imago, the perfect insect, which does not differ from the parent. But a little white insect baby is found in the termite which does not undergo any further metamorphosis; which is born weak and helpless, and grows stronger slowly, just like a human baby. Does one see such anywhere else in the insect world?

There are instances of this, but never in an insect at the same stage of development as the termite queen. Let us turn to the study of the behaviour of another creature, which is zoologically classified near the insects, but which psychologically should be in the mammal class. I am referring to the South African scorpion.

Among my tame scorpions there was a gigantic female which gained a good deal of fame. She was five and a half inches long. She first introduced herself to Mr Charlie Pienaar, by killing a full-fledged chicken in his presence. She tackled the chicken's leg, clung on, and gave one sting of her deadly lance, just above the joint. Within a few seconds the chicken was paralysed and was dead in ten minutes. Later

on she became so tame and knew me so well that I could push a finger before her suddenly and allow her to grip me with her claws. She would bring her sting into contact with my skin, before recognizing me. Immediately she would relax and withdraw her dangerous weapon. I could handle her freely. She liked being scratched gently. Shortly after she came into my possession I noticed that an interesting event was shortly to take place. I watched her continually and gave her every care, for I wished to observe every stage of the process. I must admit that in those days I knew so little zoology that I expected to see her lay eggs. I was astounded therefore to see her give birth to sixteen living babies. Fully harnessed and spurred they made their entry by pairs, small white helpless babies – but perfect little scorpions. There was no doubt at all that the delivery caused the mother much pain. I remember a woman asking me anxiously whether the young ones were born with pincers and stings, and then giving a prayer of thanks that human babies at least do not possess these.

What seemed very strange, too, was that the scorpion mother loved her queer little youngsters. Very carefully she helped them on to her back, where they remained sitting in two rows with their heads and pincers directed outwards and their tails interlaced behind them. I knew her well enough to tell by her behaviour that she would not allow any handling of her babies, so I did not risk doing this until they were fully grown. The mother would tear their food into small pieces and feed them carefully, while above them she waved her sting defensively. A more loving mother you will find nowhere else in nature.

It immediately seemed that one was dealing here with one of nature's deepest mysteries, and that we were nearing the boundaries of yet unexplored country. Of the appearance of pain in nature, no satisfactory explanation has yet been

given. Many theories have been formulated, some of them probably bordering on the truth, but I know of no naturalist who has given a well-grounded and true analysis of the subject. Those who have, by original research, even approached the secret of birth pain, can be counted on the fingers of one hand.

One realizes that birth pain is a great mystery. One knows that pain in general is a warning signal to living creatures. If pain were to disappear from this earth, life would soon cease. Without pain organic matter cannot exist. Everywhere in nature pain acts as a defence – except in the case of birth. Why then do we find this agony of suffering at the birth of highly developed animals? It plays such an important part and is so common that it must have some equally important purpose. What purpose had natural selection when she allowed this amazing exception to the general rule? Birth pain is clearly not protective; indeed, it is the very opposite. One can often learn the meaning of normal phenomena best by observing what happens in unnatural and abnormal manifestations of the same thing. One knows that in apes, in tame animals and in humans, the mechanism which causes birth pains may be a danger to the lives of both mother and child. Yet birth is the great end of the struggle for existence, the event which nature, as it were, considers the first and most important, which would protect with all her powers and would make safe for mother and child. Why should it be coupled with violent and non-protective suffering, which increases as you mount the scale of life? What does this mean? We will follow the path of pain as it winds the way through the dark ages.

With an ordinary immersion lens dipped in a drop of stagnant water from a cattle kraal, for one *can* see life with an immersion lens without stain or oil, I watched the movements of *Volvox* and *Amoeba* for hours on end. Many unnatural

conditions in their environment may be brought about. A red-hot needle pressed against the glass will cause a sudden rise in temperature of water film, enough to cause the death of a unicellular organism. One can introduce strychnine, carbolic acid, or arsenic over the outer edge of the film. A strong ray of red light, sharper than a needle point played over the film will also kill the organisms. In these experiments one gains a certain insight. One sees the unicellular animals start and retract from the dangers you have caused. If you study similar instances in higher animals, you find that nature guards the way to death by pain.

On the unaffected side of your film you see the cells budding, dividing and multiplying.

Someone once said that all behaviourism in nature could be referred to hunger. This saying has been repeated thousands of times yet is false. Hunger itself is pain – the most severe pain in its later stages that the body knows except thirst, which is even worse. Love may be regarded as a hunger, but it is not pain.

What protects animals, what enables them to continue living, what assures the propagation of the race? A certain attribute of organic matter. As soon as one finds life, one finds this attribute. It is inherent in life; like most natural phenomena it is polarized, there is a negative and a positive pole. The negative pole is pain, the positive pole is sex. This attribute may be called the saving attribute of life; and it is here where one comes closest to what appears like a common purpose beyond nature.

All animals, large and small, possess some mechanism for feeling pain, and this pain always acts as a safeguard against death. An animal struggles to get out of the water, not because he is afraid of death – of which he knows nothing – but because the first stages of drowning are extremely painful. Close to the pole of pain we find fear as another urge towards

certain behaviour. The other pole, sex, is more complicated – the final result of it is mother love.

In the apes, in a lesser degree, and in man, in the highest degree, there has been a great degeneration of both poles. In man there exists no longer any selective power against the attack of pathological organisms and thousands of organic diseases. The result is that the mechanism of pain, which developed only as a defence in nature, is brought into action uselessly as a result of the ills man is heir to, and from which animals in natural environments are free. Sex has become degenerate in man to the same degree. In nature, the sexual urge, like other race memories, needs an external stimulus before it is roused. As we have seen, this is scent alone in most mammals. Sometimes scent and colour go paired. In such cases we find brilliant colourings in the female as well as scent. In such animals destruction of the olfactory sense in the male means the end of sex.

In the ape and man we find the first animals, excluding tame animals, in which sex can be roused without an external stimulus. The reason for this is one that has been mentioned before. In man and the apes all perceptions, all experiences are registered as individual causal memories. The cortex of the brain is the organ of this function. The first awareness of sex must be transmitted through the cortex as an ordinary causal environmental memory where it is immediately absorbed as a separate memory. The ape and man remember this as a pleasurable experience to which they can react at will. The result is that the greatest of all natural laws, periodicity, is lost in the human race. The periodic organic condition, which should rouse the sexual sense, has become an absolutely useless, degenerate, pathological manifestation. The ultimate result, birth, which in all other animals is safe and certain, has become in the human a major surgical operation, where the lives of both mother and child are en-

dangered. Without skilled help in labour the civilized races would vanish from the earth in three generations, said a famous German obstetrician. Two-thirds of all the organic and mental disease of man may be ascribed to the degeneracy of the sexual sense, said another expert.

A little way behind man we find apes, with similar degeneracy and similar results, only in a lesser grade. We have taken a brief and general glance at the two poles, pain and sex. There still remains the mysterious exception, birth pain. We realize at once that this has no connection with protective pain. It guards no road leading to death; no animal can escape from it. We have learnt the general rule that every instinctive action is unlocked by one and only one key. We have seen how in the termite the stimulus or key to sex is flight, and in the kudu scent; how the whole aquatic life of the otter is initiated by the sight and touch of water. In exactly the same way we find that birth pain is the key which unlocks the doors to mother love, in all animals from the termite queen to the whale. Where pain is negligible, mother love and care are feeble. Where pain is absent, there is absolutely no mother love. During a period of ten years' observation, I found no single exception to this rule. Some naturalist once suggested that the function of birth pain was to draw the attention of the mother to the young one. This is not so. There is no such thing as 'drawing attention' in the instinctive soul. The unlocking of the mother love complex through pain is beyond consciousness, beyond the knowledge of the mother and has nothing to do with drawing her attention to her offspring. Naturally it was not enough to show the connection between birth pain and mother love in order to prove that one was the result of the other. A large number of experiments dispelled all doubt. The following notes will explain the general principle.

For the experiment I used a herd of sixty half-wild buck,

known in South Africa as Kaffir Buck. I have proof that during the previous fifteen years there had been no single instance of a mother refusing her young in normal circumstances.

1. Six cases of birth during full anaesthesia of the mother induced by chloroform and ether; unconsciousness in no case lasted for more than twenty-five minutes after delivery. In all six cases the mother refused to accept the lamb of her own volition.

2. Four cases of birth during paralysis – consciousness and feeling were partly paralysed but not destroyed by the American arrow poison curare. In all four cases the mother appeared for over an hour in great doubt as to the acceptance of her lamb. After this period, three mothers accepted their lambs; one refused it.

To prove that refusal on the part of these mothers was not due to the general disturbance caused by the anaesthetics used, I did the following experiments:

3. In six cases of birth the mother was put under chloroform anaesthesia immediately after delivery was complete but before she had seen her lamb. Unconsciousness lasted about half an hour. In all six cases the mother accepted her lamb without any doubt immediately after she became conscious. Similar experiments with curare gave the same result.

From these and other experiments I became convinced that without pain there can be no mother love in nature, and this pain must actually be experienced psychologically. It is not sufficient for the body to experience it physiologically.

Mother love is a psychological complex, therefore the key which makes it function must be a psychological one, analogous to the psychological impression of flight in the case of the termite.

We have seen what the result of birth pain was in the case

of the scorpion mother. In a later chapter we will see the interesting way in which the same principle is verified in the termite queen.

This complex, as we find in all such complexes of the instinctive soul, has long ago ceased functioning in the human. Birth pain has become psychologically a useless rudimentary manifestation, which now is a source of danger, like most rudimentary organs.

One expert has written: 'When nature wishes to annihilate a race, the first attack made is in the direction of the sexual sense.' This is said in topsy-turvy fashion, and I am not sure whether it is true. But one fact is clear, the degeneration of the sexual sense is responsible for the greatest part of human suffering. Yet one part of sex, mother love, gave a twist to man's psychological development which was largely responsible for his domination of the earth.

II

UNINHERITED INSTINCTS

I HAVE said that in the termite queen, pain accompanied the laying of the first eggs. It is usually very difficult to be certain of the perception of pain in the animal world, for the outward signs vary enormously in different races and in varying circumstances. In general, however, one may say that the outward signs of pain are more or less similar in all higher animals. If an animal is wrung by convulsive spasms, makes needless movements of its limbs, draws back the head, and at the same time moans and groans, one recognizes that it is in pain, although one may not know the cause of the pain. This expression of pain is an international language amongst animals, and even man knows it from childhood. Most insects speak the same language, without, however, the audible sounds. Therefore anyone, watching the bodily movements of the queen termite which I have described, will feel certain they are the expression of pain. If one is in any doubt, one can dispel this by actually hurting the queen and comparing her behaviour with that which occurs when she is laying her first eggs. Touch certain parts of her body with a glass rod dipped in sulphuric acid and immediately we see the identical waving of the antennae, the writhing of the body, and so on, exactly what happens when she is laying her eggs.

The greatest proof to me, however, was found in her behaviour after her eggs were laid. It is not scientific proof of course. I am trying to establish the connection between the cause and effect, and now I am taking the effect as proof of the cause. Yet everyone will grant that a general knowledge of animal behaviour can find proof in itself. When I say that

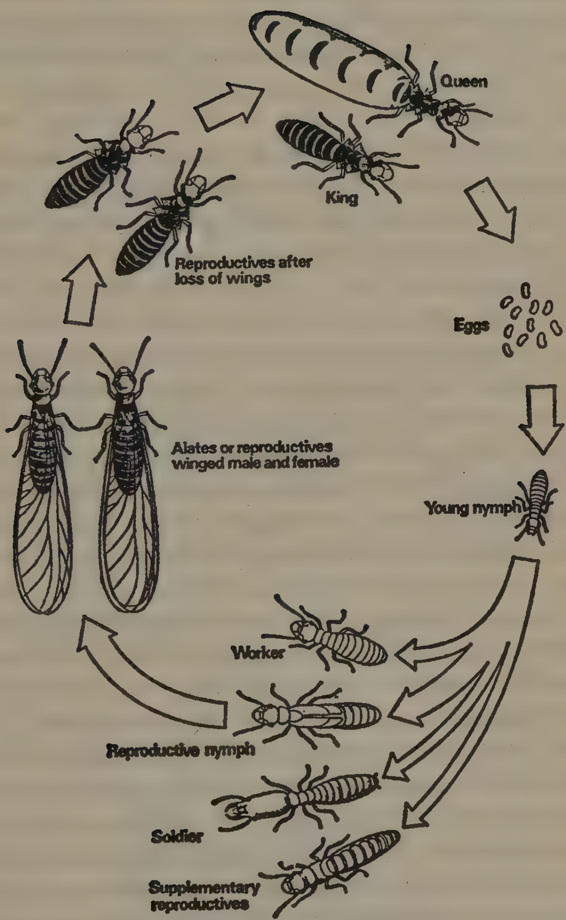
as soon as I observed the bodily movements of the queen, I immediately realized that she was in pain, and that I then could prophesy that as result of this she would in all probability show signs of affection for her young. Although both occurrences were so improbable, it only indicated that I possessed some special fragment of knowledge which could, if necessary, produce proof. Long before I made acquaintance with the queen in travail, I had come to the conclusion that birth pain was the key to mother love. Let us watch her behaviour immediately afterwards.

On the little garden patch where the first eggs are laid, we see the king and queen continually wandering around. They are busy irrigating and fertilizing the fungi-beds. Soon the first larvae appear. We see them wriggling in the garden, small, white, helpless babies, but we can already distinguish the different kinds, the so-called soldiers and the mandibulated workers. The queen appears among them. We see something glisten in her jaws. In the stream of light it looks transparent and pure as a diamond. Under the magnifying glass we see it is a drop of fluid. She approaches one baby after another, they lift their heads and you see the drop disappear. The queen is busy feeding her little ones.

As I said before, behaviour such as this is unknown in insects at the same stage of development. The nearest approach to similarity is the statement of von Buttel-Reepen that a certain bee, *Halictus*, lays her eggs so slowly that the first eggs hatch before she has laid the last, and that she therefore comes in touch with her own living young. I think that in that case it is sheer chance; but even that instance is so exceptional that stress must be laid on it. Of care and feeding, however, there is no mention.

With this feeding and preparation of the first soldiers and workers, the individual labour of the king and queen comes to an end, and so does our own opportunity for observation.

From now on the community suffers from photophobia – fear of light – to such an extent that the usual methods of observation are impossible. This draws our attention to a phenomenon which is as mysterious as the transference of the queen from cell to cell. The king and queen do not possess this instinctive photophobia. They are ordinary winged insects, and only a short while before we saw them in the sunlight flying around. The soldiers and workers, on the contrary, are totally blind and hate the light. How can they possibly inherit a hereditary instinct which the parents do not possess? Nor is this all. The soldiers and workers inherit many instincts which the parents do not possess. They begin immediately building complicated structures. They make cells, passages, aqueducts and a crust containing various forms of arch. One can separate a part of the termitary with a steel plate, in such a fashion that there is no communication between the termites on each side of it. Nevertheless the same curve of arch, or a lower one, as the case may be, is built on either side of the plate. They become aware of the presence or absence of light on the surface through twelve inches of opaque earth. They manufacture cardboard from grass-stalks and wood. They steal eggs from other termites and carry them to the breeding chambers and care for them. They take care of the larvae and feed them, but this is of course an instinct which the queen possesses. They make gardens and replant dried-up gardens. From whom do they inherit these hereditary instincts? All soldiers and workers have the same instincts. Throughout nature we find hereditary instincts of this kind inherited by an organism only from parents with similar instincts. Whence come the special instincts of the sexless forms in the community? The king and queen cannot hand them on, because they themselves do not possess them, nor do they take part in or come in touch with the communal life of their citizens; the soldiers and workers cannot hand on



The life cycle of termites

their instincts to other soldiers and workers, for they take no part in the reproduction of the race.

I must admit that all this has never seemed a mystery to me, for I felt I had long ago discovered the secret. When one knows the answer to a problem, it can never appear impossible to solve.

In some ways this is the most mysterious occurrence in the life-history of the termite. It deserves careful attention. It is a strange and interesting fact that inexperienced observers seldom become aware of these mysteries, still less do they seek an explanation.

In connection with this riddle, I want to show how modern European learning handles cases of this kind, and the explanation it finds. I am able to do this through the kindness of a correspondent, personally unknown to me, who sent me a monograph written by Professor Dr Bugnion of the University of Lausanne. Dr Bugnion has studied termites in Ceylon for some years, and this monograph is to form part of a monumental work of the famous psychologist Augustė Forel. The title is 'The Community World of the Termite'. Dr Bugnion discusses in particular the wars between the ants and the termites, with special reference to the origin of instinct. As would be the case in any tropical country, Dr Bugnion saw many instances of attacks on termites by ants. He ascribes all the instincts and variations in form of the termites to this continuous state of warfare. I must state at once that I had practically no evidence of this ant warfare in Waterberg. On the contrary, we know that one of the nimblest and most ferocious of our flesh-eating ants lives by choice in a termitary belonging to one of the most helpless of termites which possesses no soldier class. If we break open such a termitary, it is easy to get an impression of war, which nevertheless is based on inaccurate observation. There is no war; in fact most probably it is protection and friendship. This may be proved by

anyone who cares to do so. If we break down a number of the smaller termitaries, sooner or later we come upon one which ants and termites occupy together. Of this small, pale termite there is only one class, the worker. Look at them under a magnifying glass. Their manner of building is entirely different from that of the termite we have studied hitherto. The workers appear immediately at the edge of the wound. But they do not carry stones and stick these together to mend the breach. These pale termites build with clay only. Each worker who appears at the margin of the wound tests a place with his jaws, swings round with a characteristic movement and deposits a small layer of clean soft mud. Sometimes he deposits just a spot, more frequently a little layer. Dr Bugnion had the opportunity of seeing the collection of this mud, but he could not actually see what the termites were doing. What I have told will enable everyone to recognize this particular termite. Among the termitaries broken into, we are sure to find one where a section is inhabited by a dark grey ant, nimble, ferocious and excited. At first sight it appears very much as though these ants are bent on slaughter. They run rapidly between and over the termites, apparently inspired with terror and fury. Occasionally one of them will seize a termite and carry him a short distance. Sometimes a termite will grip the leg of an ant and be dragged about without apparently causing the ant any inconvenience. The wounded termites also are seized and dragged about. In the meantime the other termites quite peacefully go about their business of repairing their fortifications. The ants continually touch and test the repairs, but they never attempt to throng into the passages or to hinder the workers in any way. They appear to have special entrances to the innermost parts of the nest. The observer speedily comes to the conclusion that there is here nothing comparable to murder or war. What it actually was I had no opportunity of discovering. Much time

is necessary to study even a single phenomenon of termite behaviour in a dry country like South Africa. I believe this communal life of termite and ant, whatever its basis may be, holds many surprises in store for scientists. We find, however, in South Africa little evidence of the tropical strife of which Dr Bugnion speaks, and realize that it is extremely easy to come to unsound conclusions.

In a later chapter I will try to interpret these first labours of the king and queen. At present it is sufficient to say that with the attainment of adult stature by the workers and soldiers, systematic observation becomes impossible. The first and most important reason for this is the photophobia already mentioned. All the first efforts of the workers and soldiers are concentrated on sealing up all holes by which light can enter or the observer can watch them. If one perseveres and reopens these holes, the termites simply vanish and that is the end of the nest which took so much time and patience to bring into being. It is possible, however, by breaking into many termitaries to form a fairly accurate picture in our minds of the further course of events in the community. A cement chamber is made for the queen and she is imprisoned there. Passages are made in all directions for the conveyance of coarse food to the different digestive centres; gardens are cultivated on a large scale and planted with fungi; construction of the superficial defensive crust forms an important part of their work.

To come back to this great mystery of inherited instinct. Every organism, excepting the apes and man, inherits from its parents all the instincts, that is hereditary environmental memory, which it needs for its own struggle for existence. It is born with the knowledge of what kind of food it needs, where and how to obtain it; it knows its natural enemies and how to defend itself against them; it knows how to make a nest or other home; how to feed its little ones and to care for

them. All this knowledge is there without the organism having to learn it, without even coming into touch with the other individuals of its race. I gave an interesting example of this in the South African yellow weaver bird, which, after being kept out of its natural environment for four generations, by hatching the eggs under canaries, instinctively

(Eutermes *or* Trinervitermes.) *Mandibulated worker; water carrier, mason, probably also gardener, nurse and feeder. One of its most important functions is to bring all coarse foodstuff into the general metabolism. These workers form part of what corresponds to the blood-stream in higher animals.* Colour: *Somewhat etiolated with light red markings. Blind, no organs of hearing, sexless.*

knew how to build its characteristic nest and how to feed its young.

No one taught these birds. Four generations of their ancestors had never seen a plaited nest or tasted a worm, yet the fifth generation remembered what to do. This is what is called instinct or hereditary environmental memory. In the termite we find three apparently different insects – the queens, the workers and the soldiers, being produced from one father and mother who are completely different from two of their offspring. If one did not actually know the contrary one would believe the inmates of the termitary to be completely different insects.

With the physical difference go special hereditary mem-

ories or instincts. The soldier is armed with the first hypodermic syringe made by nature, which she eventually perfected in the poison fangs of the adder. In his polished head the termite soldier carries a little flask of poison and on his forehead a needle-like tube through which the sticky fluid is

Head of Eutermes *worker from below, showing the mouth parts. These are specially developed for purposes of building and feeding.*

squirted. He uses his weapon only against threatening enemies or strangers. The worker has strong, well-made jaws and a glue-producing gland which he uses to construct most complicated building operations. As soon as he has reached adult stature he begins to make gardens, care for and feed the king and queen, tend the hatching eggs, carry food and partially digest it for the benefit of the whole republic. Both these insects are totally blind, neither of them possesses eyes or other organs of sense; nevertheless they are aware of the presence or absence of light through twenty-four inches of compact earth.

12

THE MYSTERIOUS POWER WHICH GOVERNS

THE termites dig deep boreholes to find water, and from this source it is conveyed for general purposes. When a breach is made in a termitary, the syringe-bearing or nasicorn soldiers are the first to appear. They inspect the damage slowly and thoughtfully from all sides. If there are no workers at hand, or only a few, the soldiers begin to signal. By quick movements of the throat plates of their armour, they make a sound, a sudden *tik-tik-tik*. In houses infested by termites, this sound can be heard at night in all directions. By this signal the soldiers summon the workers to the place of attack. The same sound is used as food signal. So urgent is this call that even workers who have been appointed to special tasks, like conveying water, carrying the larvae, gardening, feeding of the royal pair, drop their work and throng to the place from where the alarm has sounded. As I have shown before, the behaviour of the two kinds of termite corresponds in every respect to the functions of the blood corpuscles in higher animals. Just as the white corpuscles make a cordon round the wound, which the red corpuscles begin healing, so the soldiers form a protective circle while the workers repair the breach. If you annoy the soldiers individually with a sharp object like a needle, they go into a kind of convulsion. Their bodies are jerked angrily from side to side and through the syringe-like weapon they squirt a drop of clear sticky fluid in the direction of the danger. This fluid appears to cause extreme pain to other small insects, glues together their

jaws and legs and renders them helpless. All these actions are instinctive.

Now we return to the question: where do they get these instincts? That their behaviour must be inherited cannot be doubted, because all the workers and soldiers possess exactly

Eutermes *nasicorn soldier, with syringe Blind, deaf, sexless.* Colour: *Head, reddish-yellow; body, blood red. Generally highly pigmented. Mouth parts, rudimentary.* Function: 1. *Part of the 'blood-stream'.* 2. *Defence, when outer layer of termitary is attacked.*

Eutermes *nasicorn soldier seen from above.*

the same instincts as the others of their type. It is impossible for them to have inherited these from their father and mother, because neither the king nor the queen possesses any of these instincts. The royal pair possess perfect eyes and do not fear the light as the workers and soldiers do. On the other

hand they do not possess a special, but inexplicable sense which enables them to perceive the dimmest ray of light as their children do. They know nothing of collective building of termitaries, of squirting poison, or carrying water. They do not even come in touch with the labours of the community; we appear to be forced to the conclusion that the workers and soldiers inherit a large number of environmental memories which none of their ancestors ever possessed. On the

Head of Eutermes *soldier from below, showing rudimentary mouth parts. In the ampulla is stored the glutinous liquid used in defence.*

other hand they do not inherit one of the special instincts of their father and mother, for they cannot fly, never copulate and never lay eggs. They themselves cannot hand on their instincts to other soldiers and workers, for they never produce young. It appears to be a paradox.

Let us see what were the observations of Dr Bugnion of Ceylon, and how he explained the mystery. I will quote what he says about his difficulties, and discuss his theories, and then give my own criticism of them.

He says:

'When the biologist, having satisfied himself that (1) the soldiers who are trusted with the task of defence, are totally blind, and that (2) the workers who do the repairs are small, insignificant insects, not more than five millimetres in length, when he sees the collective drive of the termites, he becomes perplexed and amazed. His wonder increases when

he tries to discover the power that governs the termites and the moral law which binds them together – and finds no trace of it.'

It is difficult to understand exactly what Dr Bugnion means. I think what he meant to say was: 'The biologist clearly sees the effects of a governing power and a moral bond.' What the biologist does not discover so easily is the source of this governing power and moral bond.

Dr Bugnion continues:

'Finally, the biologist is forced to conclude that the activity of these little insects, which appear to behave so intelligently and thoughtfully, is entirely instinctive.'

I must admit that intelligence and thoughtfulness, as we humans understand these, never entered my mind in connection with the termites. Perhaps I was lucky enough to discover the secret of the behaviour of the termites too soon for that; and perhaps I knew just sufficient about behaviourism in animals to prevent me from going too far astray. I say this in all humility. I know it is extremely easy to go astray in what we call comparative psychology, when one has had little opportunity of learning to know animals in their natural surroundings and when one uses human intelligence as the criterion of judgement.

In describing the wonderful collective activity of the workers and soldiers, Dr Bugnion says:

'It is amazing how they can do all this without a single mistake.' He is wrong, however, for they make many mistakes. They often go to work mistakenly and persevere in their mistakes. Remember the useless turrets in this respect, excrescences forming a danger to the community. As clever as they are in one direction, just so unbelievably stupid are they in other directions. On the other hand, Dr Bugnion must have missed perceiving the real building genius which the termite possesses or else he would not have risked giving

so decided and confident an explanation as he gives us later. The solution given above, of course, is not very convincing. To say that the work of the termites is instinctive is like trying to explain the nature of wind by saying it is *wind*. The actual problem confronting us is not whether the activity of the termites is governed by the reason or instinct, but who is the architect who designs the plans which the workers execute. Let us look at the workers through a magnifying glass. We see them appear one by one from the dark depths, each carrying a tiny grain of earth. Without the least thought, each worker rolls the pebble round and round in its jaws. It covers it with a sticky mucilage, sets it in position in the breach and vanishes again into the depths. No reasonable person can imagine for one moment that every small worker is conscious of the purpose of its work, that it carries in its mind the plan, or even part of the plan of the building operations. The tower or breach may be a million times larger than the termite itself. The workers attack the repairs from every side, and are totally blind. We can convince ourselves that the termites at one side of the breach never come into contact with those on the other side. They may fetch their materials from different parts of the nest. If we have any doubt of this we can easily dispel it. Take a steel plate a few feet wider and higher than the termitary. Drive it right through the centre of the breach you have made, in such a way that you divide the wound and the termitary into two separate parts. One section of the community can never be in touch with the other, and one of the sections will be separated from the queen's cell. The builders on one side of the breach know nothing of those on the other side. In spite of this the termites build a similar arch or tower on each side of the plate. When eventually you withdraw the plate, the two halves match perfectly after the dividing cut has been repaired. We cannot escape the ultimate conclusion that some-

where there exists a preconceived plan which the termites merely execute. Where is the soul, the psyche, in which this preconception exists? That is the problem which must be solved. Dr Bugnion says it is instinct. If we accept that, then *whose* instinct? Does he maintain that every tiny worker carries part of the plan in its little soul? The experiment with the steel plate disposes of this theory. Even if one could prove that every worker had an instinctive knowledge of part of the plan, then the ultimate problem would still remain unsolved.

Where does each worker obtain his part of the general design? We can drive in the steel plate and then make a breach on either side and still the termites build identical structures on each side. It cannot be an inherited tendency, for the termites do not always build the same kind of arch or other structure. We can find a dozen different widths of arch near the surface of a large termitary. These arches are one of the amazing features of the termites' building powers. It cannot be due to the instinctive knowledge of the individual termite. If the termite always built one kind of form, one kind of tower, one kind of arch, we might perhaps come to the conclusion that it worked according to instinctive or inherited knowledge. Even then a doubt would exist. We are inclined to imagine the termites thinking and reasoning in our own way. Yet we know that they possess perceptive powers a million times more acute than our own senses. They become aware, for instance, by a fleeting touch of another termite, that he belongs to their own nest. They then follow his trail towards food, with unfailing certainty. From this has arisen the theory of 'intelligent communication' which Dr Bugnion and even Forel still appear to credit. By touch, they can perceive alarm and agitation in a comrade and can apparently tell where the danger lies. They become aware over incredible distances of the signals of the soldiers; all these

things they sense without a vestige of a sense organ.

How can one compare this soul with that of a human being? When one sees a tiny worker hastily placing a single grain of sand on the wall of a building which eventually will become a massive tower twelve or fifteen feet high, millions upon millions of times larger than itself, can one assume for one moment that the worker knows, in the human sense, what the final result of its work is going to be? If this were so its intelligence would be that of a god, compared with our own. His work is naturally due to instinct, as Dr Bugnion says, but it is not the instinct of the worker. It is the instinct and design of a separate soul situated outside the individual termite.

If we carry our recent experiment a little further, new light begins to trickle through on our problem.

While the termites are carrying on their work of restoration on either side of the steel plate, dig a furrow enabling you to reach the queen's cell, disturbing the nest as little as possible. Expose the queen and destroy her. Immediately the whole community ceases work on either side of the plate. We can separate the termites from the queen for months by means of this plate, yet in spite of that they continue working systematically while she is alive in her cell; destroy or remove her, however, and their activity is at an end.

If the termitary under observation is in the neighbourhood of other termitaries, we can establish a few more facts experimentally. If there is a termitary within a yard or two one can prove that the termites of both nests mix freely without fighting. Place a piece of wood equidistant from both nests and spray the ground around it with water. If you expose the passages you will find that termites from both nests are destroying the wood. If you break into these two termitaries and put workers and soldiers from one nest into the other, you will find they do not get attacked. If, however, you do

the same to termitaries twenty or thirty yards from each other, then the strangers are pounced on immediately by workers and soldiers and killed. If you destroy the queen in one of the two nests adjoining each other, then the termites of that nest cease work and move to the adjoining nest where they apparently swear allegiance to the new queen. If, however, you destroy the queen of a nest which is some distance from another, the termites make no attempt to transfer to another nest, but die in their old home. The reason for this difference in conduct is, I think, this: The mysterious power which streams from the queen functions only within a limited distance. Every termite is under the influence of this power. If their two termitaries are situated close to each other, the power of each queen operates in both nests. It is through this psychological power of the queen that the termites of one nest are capable of recognizing their fellow-citizens and discovering strange intruders.

The following control experiment shows this clearly.

Take soldiers and workers from one nest and place them in a far distant nest and make certain that they really are attacked, by waiting until the disturbance caused by the breach has died down; then destroy the queen of the first nest. If you transfer termites as before immediately after you have killed the queen, you will find they are again attacked. If, however, you wait a day or two and then transfer the termites, they are no longer attacked, but are accepted as new citizens of the republic.

It appears therefore as if the workers and soldiers carry with them *something* of their own queen. We will assume it is something analogous to scent. Personally I do not think it is scent but something much more subtle. But if we think of it as scent it will simplify matters for we are actually dealing with something far and away beyond human senses.

The power of the queen reaches only certain fixed limits. It

can penetrate earth, rock and even metal plates. It evaporates within one or two days. It is the mainspring of all the collective activity of the soldiers and workers. The queen is the psychological centre of the community; she is the brain of the organism which we call a termitary.

From this shapeless, immobile object, imprisoned in her narrow vault, there emanates a power which directs all the activities of her subjects, just as our own brain rules the functions of the blood corpuscles and regulates and keeps in order the composite animal we call our body.

Dr Bugnion never discovered the psychological functions of the queen. He assumed that the king and queen possess only sexual functions. He therefore is checked by all kinds of inexplicable difficulties which simply do not exist for me, and the explanations which he gives are at times ludicrous. If only he had had the opportunity of accompanying a professional South African termite-catcher he would without any doubt have discovered the secret. This chance I was fortunate enough to have had. His greatest difficulty was the problem of where the soldiers and workers get their hereditary memory. He found two solutions. The first was founded on the fact that some observers discovered individuals of the sexless forms possessing perfect organs. He assumed, therefore, that the sexless forms were at one time fertile. Then he says:

'Given these facts, we have only to conceive of the period during which the defence methods were perfected as coinciding with the period during which the workers and soldiers were fertile in order to render more plausible the hereditary transmission of the improvements in question and of the instincts (neoform) related to them.'

If this is so, he must accept the theory that the present queen and king types are descended from the present sexless types. That cannot be true, instead the very opposite is actu-

ally the case. I do not think any one can fail to accept the theory that the termite was originally a single flying insect of the same type as the present king and queen. The founding of community life was the cause of the physical differentiation into workers and soldiers. With these changes new instincts arose. The laying of eggs by workers is a very rare occurrence. One also occasionally finds rudimentary eyes and wing-buds in a few soldiers. These are all atavisms, which show that the original termite was a fertile flying insect. One thing is certain, both the changed physical characteristics and the new instincts are transmitted by the queen, although she does not possess, nor did she ever possess, either of these things herself.

There is another fact which Dr Bugnion has not touched on. How does it happen that the soldiers and workers not only inherit instincts which their father and mother did *not* possess, but also do *not* inherit the specialized instincts the father and mother *do* possess?

The second explanation which Dr Bugnion puts forward is somewhat surprising. He must have been very much mystified when he wrote the following:

'As the workers and soldiers live in the interior of the compartments in the company of the sexual forms until the moment of swarming, it is not entirely incredible, judging by the above suggestion (that the ants and termites carry on intelligent communication with each other), that while they are living together they should exchange a few ideas. As a result of these communications new instincts acquired by the workers and soldiers would become the property of the community as a whole.'

If Dr Bugnion had said that he had seen a termite soldier giving birth to a whale it would not have sounded more 'entirely incredible' than the above statement. The workers and

soldiers are supposed to tell their work and plans to the queen. She remembers what she is told and conveys this garnered knowledge to later workers and soldiers born to her. Dr Bugnion still believes in the 'intelligent communication' of ants and termites. He calls it 'antennae-language'. I was under the impression that this fairy tale had been relegated to the nursery where it belongs. Everyone should be convinced by now, I hope, that there is only one conclusion which accords with all our knowledge of termite behaviour: The individual worker or soldier possesses no individual instincts. He forms part of a separate organism of which the queen is the psychological centre. The queen has the power, call it instinct if you will, of influencing the soldiers and workers in a certain way, which enables them to perform collective duties. This power or instinct she transmits to all queens born from her. As soon as the queen is destroyed all the instincts of workers and soldiers cease immediately. She transmits this psychological power to the future queens just as she transmits to them the power of producing three infinitely differing forms of insect: the queen, the worker and the soldier.

At times Dr Bugnion comes extraordinarily near to discovering the secret. He says:

'The multifarious duties, which are carried out under our eyes by the soldiers on the one hand and the workers on the other, give us the illusion of a higher direction, whereas in reality this direction does not exist, or if it does exist resides solely in the community as a whole.'

Again later he says:

'The male and female individuals which are described in the higher termites as king and queen, have no authority and possess no power of any kind. The king and queen termite shut in their closed cell do not even know what is happening outside. It would be impossible for them to give orders from

the depths of their prison.' One notices that Dr Bugnion constantly talks of the termites as if they have human understanding: 'to know and to give orders'!

He thinks anthropomorphically all the time. He assumes that the termites are able to 'talk', but that touch is necessary for this. He does not think of a subtle immaterial influence which functions at a distance. If only he had put this question to himself: How does the queen hold the community together from her cell in the depths? There are millions of her subjects which never come in touch with her, which have never seen her. But as soon as she is destroyed there is an immediate end to the community as such. Our 'ant-catchers' here in the Transvaal never attempt to destroy directly the millions of workers and soldiers in the nest, they take out the queen instead. For every queen they receive a fee of two pounds. Dr Bugnion, and every observer, must at least become aware of this sustaining power of the queen; if he becomes aware of this, he must realize that she has functions other than merely sexual; that at any rate in this direction she has some psychological function which neither depth nor imprisonment can thwart. From this realization it is only a step further to the discovery of all her psychological functions. With as much reason for objection he might ask: How can an organ like the brain which is shut up in a vault, direct and know the functions of the blood corpuscles even in the toes?

One more word about explanation of the origin of the instinct of the termites. He says:

'The origin of most of these instincts is a reasoned and conscious action.' I find it difficult to believe that this explanation could be made seriously today. What would Dr Bugnion say of hundreds of our South African desert plants which attain all kinds of far-off objectives by the cleverest plans? Have these plants also reasoned and thought in

human fashion, thus solved one difficulty after another, and transmitted this knowledge to their descendants?

All this discussion has been caused by the wonderful change which has taken place in the termitary from the time when we saw the queen feeding her young ones and when a few months later we open the palace cell for observation. It is difficult to make clear to the uninitiated reader why this change is so amazing to the psychologist.

In the first instance we were observing an ordinary flying insect at work, behaving in the normal way with normal reactions, except of course the birth-pain and mother-love reactions. Now, at our later observations, a new soul and a new body have appeared. The queen is no longer an insect. She has received a new soul. What has she become? How can one classify her? The biologist who thinks the matter over carefully will find difficulty in finding a place for her in a classified list. The soldiers and workers? The psychologist would say that these too are not insects. He classifies all living organisms according to their behaviour. The workers and soldiers, with only the merest semblance of an individual psyche, fall outside all classes. We are reminded again of the fairy godmother who waves her wand – the pumpkin becomes a coach, the mice prancing steeds.

I find it simple to form an image of the general trend which development took in the case of the termitary. In any case, it seems unnecessary to look for miraculous reasons for this. It is unnecessary to suppose that the termites are capable of talking, thinking, acting and remembering in human fashion. One would have expected an observer to find the simplest explanation first. Dr Bugnion's demonstration shows us that this is not always the case. His two theories are based on the hypothesis that the termites are simply small humans to whom 'an exchange of ideas' is possible. The queen, before

her flight, walks round the nest, and comes into touch with the workers and soldiers. She studies their community life and there is 'an exchange of ideas'. From this point Dr Bugnion becomes more and more difficult to understand. What he appears to mean is that the queen remembers the lessons she learnt from the workers and soldiers, and although she never herself takes part in their labours, although she herself never shows any signs of the specialized instinct which animates the workers and soldiers, yet in spite of this she transmits these lessons to her offspring. According to Dr Bugnion the queen does something which man has not succeeded in doing. Man does not transmit a single acquired memory to his progeny. The son of the greatest mathematician does not inherit even the multiplication table.

This theory savours too much of magic. Dr Bugnion found himself in very deep water. There is not a single fact or condition in nature or in the life history of the termite which justifies his opinion. It must have been pure inspiration. There is one great difficulty which Dr Bugnion never saw, for he leaves it unmentioned. Suppose his theory is right, that the queen transmits in this way the special instincts to her offspring. There still remains the problem, how does it happen that the queen gives birth to two kinds of insect which resemble her as little as a scorpion does a butterfly? This cannot be due to the lessons she learnt from the soldiers and workers in the original termitary. Why does she transmit the special instincts only to two kinds of young, which do not inherit her own instincts, while she does not transmit these acquired instincts to the third offspring, the potential queens? The last type inherit not only her own physical form, but all her special instincts and not a single one of the instincts of the soldiers and workers. His theory cannot be the true one.

His other theory is that the soldiers and workers were

at one time fertile and that the present types are the descendants of soldier and worker ancestors when these were fertile.

I have tried to show before that this is a topsy-turvy assumption which cannot be held. Besides, there still remains the difficulty of explaining how the queen manages to divide her inherited memories, some of which are latent, among her three types of offspring.

Let us compare all this with my own theory. I believe that the termite was originally a single flying insect exposed to all kinds of dangers. To keep her eggs and offspring safe she took refuge in an underground shelter. Here, just as happens with the bee, *Halictus*, she came into touch with her young after they were hatched. This was the beginning of community life.

Finally, to cause the community to function well, there was a division of labour. Some of the insects had to build and look for food, others had to protect the nest. Compare the story of *Siphonophora* mentioned already. The queen who tended to produce offspring more suitable for the various kinds of labour would have a greater chance of survival than one who did not have this tendency. Natural selection began to operate. The present-day soldiers and workers were the fittest types for protection and building operations and the sexual types for reproduction. The queen who had the tendency to produce these three types had more chance of survival and transmitted this tendency to the females born from her. Natural selection thus operated in two directions. The nearer the workers and soldiers came physically to the present-day types, the more chance had the community of surviving. A queen was selected naturally, therefore, who gave birth to all three types. Finally a queen and king were selected who not only produced these three types, but who possessed the psychological power to influence the com-

munity and to take the place of the individual instincts of the workers and soldiers.

It is easy to understand why it was an advantage to the community for the sexual sense to be destroyed in all types. Even the sexual types (potential kings and queens) possess no sexuality while they remain in the termitary. Sex in such a community would have been a disturbing influence which would have suspended all protective and other work over long periods. In order to do the best and ceaseless labour, the workers and the soldiers had to become mere automata governed by the psychological power of the queen. For the same reason, they lost their sight and other senses which are the accompaniment of an individual psyche. The soldiers and workers therefore inherit no special instincts from their parents. It is the queen who inherits the power of transmitting the semblance of such instincts to the automatons who work for her.

13

THE WATER SUPPLY

In many parts of the world we find people studying the life-history of termites. In spite of this, no single observer seems to have discovered the psychological functions of the queen, but, more surprising still, no one seems to have realized the intriguing mystery of the constant supply of water of the termite. M. Barthellier, a Frenchman, has studied the termite in Indo-China, in districts probably as dry as Waterberg. An Englishman, Carpenter, studied certain termites for a long time in British East Africa; Maxwell Le Roy in India; Prell, a German, in German East Africa; the Belgians Hegh and Ghesguière in the Congo; Hill in Australia; and many others in parts of North and South America. The collected works of all these observers and many others would fill a library. Yet none of them ever sought to answer the questions:

1. Why does community life of soldiers and workers cease when the queen is destroyed? and
2. Where do the termites get their water?

The very facts seem to have escaped their notice: the never-ceasing supply of water during the dryest seasons, and the change of behaviour caused by the destruction of the queen. If one fails to notice these things, of course, the problems and unavoidable investigation of them will not arise. I want to describe my own observations on the conveyance of water. I was much impressed at the time by the result of my observations and also the effect they had on the other spectators. I think the behaviour of these people was as interesting as the behaviour of the termites. It was sheer chance which gave me

the opportunity of watching for months the terrific struggle – it was verily struggle between life and death – unfold itself like a film on the screen. It was during the most severe drought which had ever stricken the Waterberg. That none such had occurred within human memory was certain, for on the farm Reitfontein 1638, where my observations took place, a sixty-year-old orange grove was entirely destroyed by the drought. Nature showed by many signs that it was the peak of a period of drought which had been gradually but systematically increasing for over three hundred years.

Just behind the farmhouse on Rietfontein was a range of hills which divided the farm in half. On the brow of the range were innumerable castles of the Waterberg termite. Many of these termitaries had been dead for some time but just as many were, during the very worst of the drought, alive and intact. I had often before pondered over their secret water supply, but at this time it became a bewildering riddle to me. The whole atmosphere was so dry that even at night there was not the least semblance of dew.

The whole surface of the farm was intersected with canals and ditches, and it could be confirmed by careful examination that along the range there was no trace of water in the earth to a depth of forty feet. With really hard labour we opened two termitaries situated on the summit of the hills. In one we found an eight-foot cobra* which covered old Mr Gys van Rooyen and myself with venom. Both of us received it full in the face, but luckily our eyes escaped.

In both these termitaries the palace cavity was six feet below the surface of earth as hard as rock. Yet the whole of the palace cavity and the fungus gardens were moist. In the palace cavity the temperature was two degrees above the

* The 'ringhals', or ringneck, of the Boers, *Naja nigricollis*, which has the power of spitting its venom to a range of about six feet. It aims at the eyes and is very accurate.

normal blood temperature of the human. Water vapour was present in all the passages. The queen and all her subjects appeared to be perfectly normal.

The only unusual feature we found was that many of the gardens near the palace had dried up. Where did the termites obtain their water? I must confess that I came eventually to the solemn conviction, that the termites in some way or other manufactured water from oxygen and hydrogen. Where they obtained the hydrogen was another inexplicable mystery. But I knew the termites were capable of many wonderful things and my solution seemed the only possible one.

I first came on the track of the truth through an account given me by Mr Jan Wessel Wessels, one of the finest of practical naturalists. He told me that while he was living in Bechuanaland he had twice observed in wells vertical canals made by the termites to incredible depths in order to reach water. Even this I felt was a solution which was difficult to accept.

The termites on the range at Rietfontein would have had to go down vertically to a depth of at least a hundred feet to obtain water.

Then again all our attempts to find the beginning of such an aqueduct were unsuccessful. Later we discovered the reason for this. It was only the widely known and undoubted trustworthiness of Mr Wessels which allowed me to accept the explanation as the true one. Then mere chance ordained that I myself was able to see the whole business functioning.

In this terrible drought, it was not only the termites who were seeking water, but we humans too. On the brow of the aforementioned range was a clump of green bushes which contrasted agreeably with the parched veld. Mr Van Rooyen thought there must be water at this spot and his belief was upheld by a water diviner. Men immediately began excavating a square pit in the centre of the green clump. When

the pit was about forty feet deep I was told by the labourers that a termite runway was visible on the north wall for its whole depth, and I lost no time in going to the spot to study the amazing work, in detail. The first fact I established was that the termitary connected with this canal was at least thirty feet away from the pit. I exposed the whole tunnel and also part of the gardens adjacent to the palace cavity. The latter I covered with a wooden lid, to enable me to observe them from time to time. I then discovered that the aqueduct did not descend vertically from the nest, but from the end of a long horizontal passage. This was the reason for our failing to discover it in the termitaries we opened.

I was then enabled also to discover a fact in relation to termite behaviour which would have helped me to infer the existence of a shaft into the depths, before actually seeing one, if only I had been able to reason clearly. When the ground is wet, in rainy seasons, the workers always begin repairing any damage to the outer crust immediately. In dry seasons, however, it takes hours, sometimes days, before the builders make their appearance and tackle the work. No wonder, if each little worker has to descend hundreds of feet to get his masonry. But this solution escaped me. I simply did not think of it!

Another noteworthy point in connection with the vertical shaft was that in one plane, north and south, there were absolutely no bends. In the other plane, east and west, there were many unnecessary bends. This meant that the shaft was visible through its whole length on the north wall of the well, in spite of the turnings east and west. The vertical direction in one plane was of course a great labour-saving to the termites; but why did they not make the borehole absolutely vertical? Their method, like everything else they do, appeared almost but not absolutely perfect. They are extremely wise in some ways and so very stupid in others.

It is possible that the magnetic poles of the earth may have had an influence on this work of the termites. In Australia is found a certain termite, the Magnetic White Ant, which builds an elongated termitary with the longer axis pointing north and south. In their case there is no doubt that building is determined by the magnetic poles of our sphere. So remarkable are the bends occurring only in one plane in the aqueduct of our termites that for the present we may accept the theory that the perpendicularity in one plane is due to the magnetism of the earth. East and West there is no magnetic power to keep the termites in the vertical direction. Every two or three feet in the shaft was situated a small white garden patch, dry and unplanted. It should not be forgotten, however, that I probably never saw more than half of the shaft. At a depth of forty feet, the well was abandoned because the ground even there was still as dry as a bone, whereas Mr Van Rooyen and the water diviner had thought a plentiful supply would be found at twenty-five feet. The distance of the nest from the bottom of the well was sixty-five feet, and here the shaft disappeared into the earth. There is no doubt that there were live gardens deeper down and nearer the water.

I constantly examined workers coming up the shaft under the microscope and nearly all of them had hyphae, seed ready for planting, in their bodies. During my observation I came to certain conclusions:

1. That the community could not exist a single day in the terrible drought without water.

2. That this could be the only shaft by which water was conveyed; for even for workers like the termites it would take years to reach that depth.

3. That they were forced to use this shaft in spite of their intense aversion to light.

It was impossible for them to make a new shaft, and there

was no chance of covering in the old shaft, for haste, haste and haste again had to be the war-cry of the termites in the terrific struggle in which they were engaged.

In the end I was proved correct in all my conclusions. It was one of the few times when one could prophesy with certainty. I had the opportunity of watching their struggle for existence for months and of learning and understanding step by step all that was happening. During this time I visited the shaft at all hours of the day and night from sunset to sunrise, and never for one moment did I discover any cessation of the infinite labour. Nor was there even the least slackening. Once I marked a number of workers with aniline blue and could establish the fact that they never rested or slept, that they worked day and night, that the same workers who were marked by day were busy at night climbing up and down.

It is noteworthy that in the beginning I did not get the impression of haste and alarm which I received so clearly some time later. There were two streams of workers, those on the right going down, those on the left going up, and this order was maintained to the very last. The two streams were in single file, with a distance of about two inches separating each termite from the next one. The workers I marked took, in the beginning, about half an hour to reach the end of the shaft and return to the nest with their load from the depths. Later on this period shortened until it became about twenty minutes.

I then became aware that the whole character of the activity was changing. There was a slowly increasing concentration on the aqueduct, the streams of termites became thicker and thicker, and I got an impression of general consternation. It took me a long time to discover the real reason for this. I could see they were occupied with some task which taxed the energy and power of resistance of the community to

the utmost. What exactly did it signify? There was a complete cessation of any repair work. No attempt was made to cover over the shaft. A breach made in the termitary was simply ignored, while all workers and soldiers in the neighbourhood disappeared. After a week or ten days a meagre cordon of soldiers appeared at the edge of the wound, and then sporadic attempts at repair were made by the workers. The necessary building materials were brought from the depths of the shaft. My own inference was that all the disturbance and heightened circulation was concentrated on the palace cavity, and that the object of it was to convey water to the queen, larvae and soldiers. I knew that the queen was merely a bag of liquid; that she laid on an average one hundred and fifty thousand eggs every twenty-four hours, and that for the purposes of all her functions she must require a constant and copious supply of water, while ninety per cent of the bodies of the rest of the termites consisted of water.

But the provision of water to the living termites was not the only reason for this quickened pulse. When I exposed the outer gardens, I noticed there, on a line dividing the gardens in two there was a constantly crawling throng of termites. I had forgotten that for the king and queen, for larvae and soldiers, these gardens were just as necessary as a water supply. The gardens, as I explained before, are digestive organs without which the community could not exist for even one day.

All the above-mentioned types are entirely dependent on the gardens, for the workers are the only type which can make use of partially digested food. The gardens are the stomach and the liver of the composite animal. The workers are the mouth and teeth. Long and very careful observation was necessary to enable me to understand what the enormous concentration on the gardens meant. At last I noticed that all the gardens external to the line I have mentioned were

parched and that this death of the gardens was creeping inward from day to day. It was on this line dividing the dead gardens from the living that I found the greatest concentration of activity. It took the form of a terrific onslaught, engaged in with such fury that the workers and soldiers could spare no moment for rest. It was a mighty struggle against death's stealthy approach; there was no respite for the defenders day or night.

The workers were engaged in replanting hyphae round the living gardens, and in irrigating these freshly planted seeds; and every little seed, every drop of moisture had to be carried a hundred feet out of the depths of the earth. Sixty-five feet of this distance was visible to me. During the night the defenders would gain ground. During this cool period when evaporation was at its lowest ebb the line would be pushed outwards a half or a quarter of an inch. During the heat of the day, however, the enemy would press heavily and gain the hardly won advance.

It was at night, during the hours when the rest of nature was quietest, that the fierceness of the fight gained most frenzy. I could hear distinctly the unceasing alarm calls of the soldiers, a sound which roused even in me a feeling of terrible anxiety. My electric searchlight revealed the restless stream constantly passing to and fro, as sure and indomitable as fate itself. Nothing could turn them from their purpose, no external terror could distract them. The death of a thousand individuals made not the least impression on that living stream. Vaguely and faintly, I began to realize, as I watched, what the struggle for existence really means in nature.

14

THE FIRST ARCHITECTS

I SUPPOSE every investigator of termite classification or behaviour must at one time or another have been dumbfounded by the ambitious nature of their building and engineering operations. The mightiest structures man has built on this earth; the Pyramids of Egypt, London's Underground system, New York's skyscrapers, the Simplon tunnel, the biggest cathedrals, the longest bridges, these, compared with works of the termite, taking into consideration its size, are as mole-hills compared with mountains.

Wilhelm Bösche, in *Der Termiten Staat*, made some calculations to show how the work of man compares with that of the termite. Taking size into consideration, man would have to erect a building as high as the Matterhorn, that is 14,760 feet, if his work was to be equal to a termite tower forty feet in height, such as is often found in Africa. Such was the estimate of the German writer. It is not the size of the termitary only, however, which amazes the investigator, but the almost incredible extent of their underground activity.

I have already described at some length their vertical bore-holes, those mighty feats of engineering which they have been forced to carry out in their ceaseless struggle against drought. They are forced to penetrate the bowels of the earth in their eternal search for water, which they have to convey drop by drop in order to keep their large communities from death. The actual depth of these shafts we do not know; the one I have mentioned before was deeper – exactly how much deeper is uncertain – than sixty-five feet.

I want to give an account of some facts which came to my knowledge when I made a journey through the valley of the

Limpopo and the Lowveld of Zoutpansberg a few years ago.

It was during this journey that I came to a real appreciation of the astounding genius for building which the termites possess. Everyone who is interested in the termite will have read and probably seen photographs of the enormous termitaries which are found in tropical parts of Africa. In the Lowveld of Zoutpansberg I found some giants, nor were these the exception by any means. In some parts of the Limpopo valley these gigantic termitaries are a very usual feature of the landscape. An engineer friend of mine, Norman Hugel, carefully measured and calculated the weight of earth making up one colossus, and found that it consisted of eleven thousand seven hundred and fifty tons of earth. This termitary belonged to a small *Eutermes*. Just think of it, eleven thousand seven hundred tons which had been piled up grain by grain, for *Eutermes* never uses mud for building purposes. They use only microscopic grains of sand; every one is rubbed clean and polished before being coated in a sticky cement; then every tiny stone is carefully placed in the right place. So grain by grain, the termites heaped up a structure weighing eleven thousand seven hundred tons. One would imagine it to take thousands of years to accomplish, but it was hopeless to try to estimate the period of time. There is no doubt that it was a matter of centuries. There is yet another mystery connected with this particular activity of the termites, which I cannot recollect ever to have been mentioned by other observers. The riddle is simply this: From where does the enormous mass of earth come? One would expect to find a hollow cavity below such a vast excrescence; a hollow in the earth corresponding in size to the superficial mass, because there is no doubt that all the building material is carried from below. No signs of any cavity have ever been found, however, notwithstanding the fact that many of the giants have been intersected in

many parts of Africa and have even been totally demolished for purposes of road-making, railway lines, house building, dams, aerodromes and all the many activities to which civilized man is prone.

For instance, in order to level the surface of the Bulawayo aerodrome alone, twenty thousand tons of 'ant-heap' were carted away. In all such cases, especially for purposes of making railways, dams or heavy buildings, the ground is always carefully tested for cavities after the surface termitaries have been removed; yet no hollows corresponding in size to the superficial structures have ever been found. Yet we know that the building material of the termites must come out of the earth.

The reader will remember how I discovered the source of the termite water supply by sheer chance after it had been to me for many years such an unsolved problem that I had come to the conclusion that the insects manufactured water from hydrogen and oxygen.

I believe now that if I had given the matter more thought and reasoned more clearly, these giant termitaries with no cavities below them would have led me to the truth. In the first place millions of gallons of water were necessary to build these structures, and a further inexhaustible supply for the needs of the termites themselves and the internal economy of the vast termitary. A quite considerable stream of water must flow into the nest day and night to keep alive the community. The explanation stares one in the face: Both water and building material come from innumerable tiny cavities in the earth, which the termites are constantly increasing, for the purpose of enlarging the termitary and their water supply as the community grows. It seems a kind of vicious circle.

In another instance I found a rocky kopje or hill in the Sabie Valley, which consisted of one vast termitary belonging to the much-feared *Macrotermes bellicosus*, the Fighting

Termite. The bite of the bloodthirsty soldiers of *M. bellicosus* goes deep enough to cause considerable bleeding. One of these soldiers I took back to Pretoria with me and managed to keep alive for a week after his separation from the nest. He could bite right through the wood of a matchbox with a crunch which was distinctly audible at a distance of four or five yards. This termitary, comprising as it did a whole kopje, caused me a great deal of mystification. I simply could not accept for one moment the notion that the huge rocks on its summit had been heaved up by the building operations of the termites. It is true that Dr Preller and I found stones weighing ten and twelve pounds high up in the termitaries of *Eutermes* at Pelindaba, which could only have got there through elevation by the termites. But on the kopje were rocks hundreds of tons in weight. Every inch of ground between and under these rocks consisted of the pebble-built structures of *M. bellicosus*. The probable solution was that the termites had first removed all the original earth between the rocks and then substituted their own pebble work.

I had never seen anything like this occurring, however, and the question of what they had done with all the original earth still remained. For there was no sign of normal earth.

I have mentioned this case merely as an illustration of the countless insoluble problems which constantly confront the investigator.

During this journey I took the opportunity of doing some experiments to find out in what way and how far magnetism affects the termite. Mr Piet Haak of Pretoria kindly lent me a dozen of the strongest steel magnets obtainable. I speedily became convinced, however, that my magnetic field was too weak. To come to any certain conclusion, a powerful electromagnet would have to be used. I have no doubt, however, that the magnetic force of the earth influences the work of all termites. In this connection, one should remember the water-

shaft at Waterberg which had bends only east and west.

The 'Compass Termites' of Australia build their termitaries with the narrowest diameter towards the magnetic north. The late Mr Claude Fuller alleged that the summits of the termitaries of *M. bellicosus* always leant towards the true west.

In the Lowveld we established the fact that the termitaries of *M. bellicosus* were always narrower in one plane than the other. A straight line through the widest diameter always pointed true east and west. In the neighbourhood of these last-mentioned termitaries there was a palm tree of 160 feet in height. Quite by chance I found a covered-in termite runway going up the trunk and vanishing in the foliage above. On investigation we found that this passage was used by *Eutermes* workers for the purpose of fetching water from the top of the palm to their termitary, which was sixty feet away from the foot of the tree. I took the opportunity during this time, too, of studying the art of the *Eutermes* builders in more detail, and while observing the building I found the subject of nutrition constantly looming large. Claude Fuller and other famous observers call *Eutermes* the Haymakers, and take it for granted that the grass collected by these termites is used for food. When one examines a termitary belonging to *Eutermes*, one finds that many passages are filled with dry grass stalks of about half an inch in length. This grass is carried to the termitary at night through passages which spread out in all directions. At intervals in these passages there are storerooms where some of the grass is carefully stowed and even actually inside the termitary there are sometimes parts filled to such an extent with grass that there is barely room for soldiers and workers to pass. 'Food' says my friend Claude Fuller and 'Food' bay the other observers, without any doubt arising in their minds.

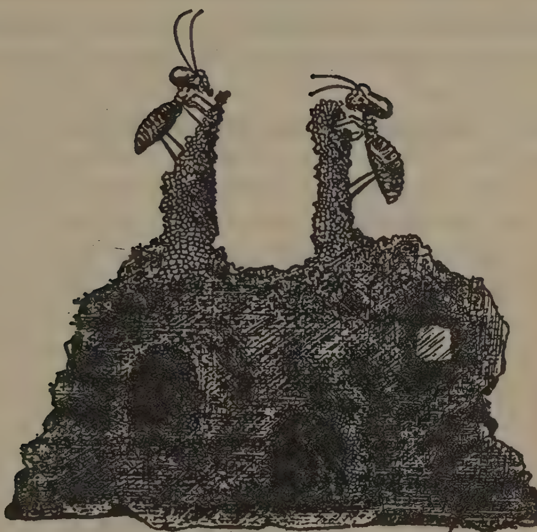
It must be food, they decide, because such a large quantity

is stored and so much of their activity is centred on collecting it. There could have been no other basis for their conclusion, though no one has ever seen *Eutermes* eating grass, nor has anyone found grass within the body of the termite.

I myself threw this theory overboard many years ago. I convinced myself by microscopic examination that *Eutermes* was not equipped for chewing grass and swallowing it; I doubt very much whether the worker could do this. Its mouth parts certainly are more developed than those of the soldier, but this development is directed towards special functions – the conveyance of grains of sand, coating them with sticky fluid, the feeding of fluids to the queen and the larvae, and severing grass stalks. But they are quite incapable, it seems to me, of masticating and swallowing the latter. Another reason which made me question the food theory was because I never succeeded in finding under the microscope the least sign of grass in the entrails of the workers or soldiers. All that I found was a fluid which had every appearance of being derived from the moisture of the earth and the sap of plant roots.

Later I learnt of certain observations in South America which strengthened my conclusions. I have mentioned before that the habits of ants and termites are often so much alike, that the behaviour of one affords a key to the behaviour of the other.

In South America and Mexico there is an ant known as the leaf-cutting ant, which does great damage to trees by cutting round pieces from the leaves. These they drop to the ground where other workers are waiting to pounce on them and bear them to the nest. Without any further investigation, it was assumed that these leaves were used for food. Recently, however, an observer in Mexico proved that the leaves are never used for feeding purposes. Instead they are packed in masses on the side of the nest where the heat of the sun is most



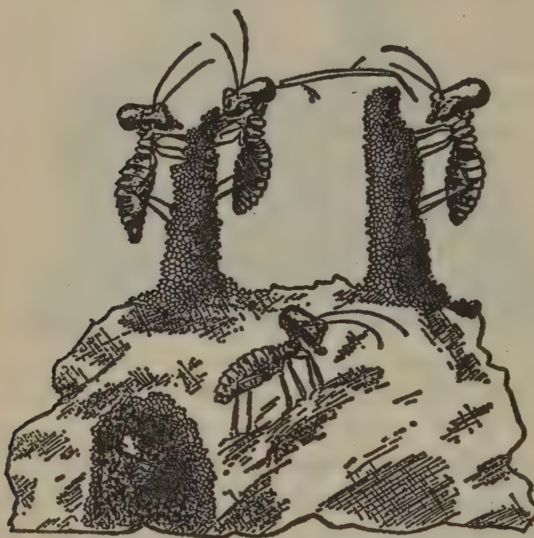
Eutermes workers building an arch by gradual approximation of two pillars.

fierce. The theory of this observer is that the leaves serve the sole purpose of protection against the rays of the tropical sun. Whether this is so, we cannot say, but at all events the leaves are not eaten and do not serve as food. I then wondered whether *Eutermes* might be using grass for the same purpose. I soon realized, however, that this could not be the case, for the method of storing would not enable the grass to serve as a protection.

Now all the architecture of *Eutermes* is based on the arch. Probably they were the first architects to discover the secret of arch building. It took years of civilization before man discovered how to use the arch in architecture. Those mighty builders, the Egyptians, knew nothing of the arch and limited themselves to two vertical pillars with a colossal stone as

crossbeam. The Greeks and Romans did not understand the properties of the arch. It was only in the Middle Ages that architects came to understand fully the value of the arch in building.

It is very interesting to note that we find in the archi-



Eutermes *workers building an arch. In this case a grass stalk is laid from pillar to pillar, and covered with tiny pebbles.*

tecture of the termite two stages of development of the arch, analogous to that in human architecture.

Let us return to *Eutermes* and examine some new building operations after rain has fallen. One portion of the termitary has a dark stain. If we examine this with a magnifying glass we find that it is a wet patch where the outer crust has disappeared. It is possible to cut away a small piece of this without causing enough disturbance to make the workers disappear.

Now we can examine the building of the first architects of this earth. We see that all the building of *Eutermes* is based on the arch. This arch is formed in two ways; the first and most primitive is made by inclining two vertical pillars towards each other until they meet. This is the way man, too, made his first arch. But about every eighth worker carries in his mouth a grass-stalk instead of a pebble. He ascends one of the pillars, quickly fastens one end of the stalk with sticky fluid to the top of the pillar, and then rushes away without waiting to see what happens. This is what does happen: the grass-stalk sinks slowly towards the other pillar until its end comes to rest on the summit. There we see another worker waiting in readiness. As soon as the end of the stalk comes within his reach, he stretches up, grips it, and pulls it down to the summit of the pillar where he in turn attaches it with fluid. On this crossbeam the termites plaster tiny pebbles until a perfect arch results. Success is by no means always inevitable. Occasionally the stalk remains vertical instead of sinking down. In these cases the termites simply finish the arch by inclining the tops of the vertical pillars towards each other until they meet, while the stalk is eventually covered with masonry. Why the stalk is used at all when the termites are able to finish the arch with pebbles only, I cannot tell. Perhaps it is only a rudimentary remainder of a principle which has disappeared. Whatever may be the explanation, I am positive *Eutermes* never uses the grass-stalks as food.

15

THE QUEEN IN HER CELL

It was not until long after I had published most of my observations that I for the first time had an opportunity of investigating at my leisure the most important phenomenon in the psychological life of the termite. By this I mean the behaviour of the queen, as a living and active part of the community. I had attempted hundreds of times on the veld to expose the palace cavity in such a manner that the functions of the queen and what occurs in her immediate vicinity would be visible to me. I am referring of course to what happens in a full-grown termitary. I had had the opportunity of watching the development of a nest, but my observations were of necessity curtailed, and gave no inkling of what happens later when the queen is sealed in her cell and continues life as the brain of the community.

An opportunity came my way quite unexpectedly in Pretoria. There was a house in Arloius Lane which had been infested with termites for years. They were continually causing great destruction and a number of attempts had been made in vain to rid the house of them. The queen had never been found and immediately the damage to the house had been repaired the termites began their work of destruction anew. At last the Town Council undertook the work of exterminating them. Mr Victor Foster and I followed with great interest the labours of the workmen while they were trying to track down the queen. After the searchers had tried in vain for many days to find the palace cavity I made a proposal to the foreman. I was convinced that in this case there was only one queen and that the community was not one which was influenced by two or more queens, where the subjects would

swear allegiance to another queen if their own were destroyed. I suggested that I would point out the palace cavity on condition that I might observe the living queen for two or three days. To this proposal the foreman agreed. Within a few minutes I had established three main passages and their point of intersection, and was then in a position to point out with a fair degree of accuracy the place where the queen's cell would be found. The palace cavity, luckily for us, was under a hearth in the darkest corner of one of the rooms. Mr Foster and I exposed this ourselves, with the help of an electric torch. We succeeded in cutting first the palace cavity and then the actual cell of the queen in half without causing any undue disturbance to the community. We simply carved away a portion of the skull and there before us lay the living, functioning brain of the organism. It was indeed a spectacle more wonderful than I had expected. How I regretted we had stipulated for only two or three days!

Some of the phenomena which this exposure revealed to me I was acquainted with, and for these I watched. Others came as complete surprises, and revealed amazing secrets. This was what we saw. The queen was enormously big, and lay with her body pointing east and west, her head towards the west. The king, who of course was only the usual size of the flying termite, was constantly either on her gigantic body or in its immediate neighbourhood. There was nothing in his behaviour which could in any way establish his function, although I made detailed notes on his every movement. A large mass of the smaller class of worker was in constant movement on the queen and around her. Immediately in front of the head of the queen was a small opening which served as entrance and exit and which was, of course, far too small for the queen to pass through. Through this small opening two streams of workers were constantly passing, one stream coming in and another going out. We very soon estab-

lished the fact that these small workers were occupied with three different tasks:

1. One stream was engaged in feeding the queen. Each worker stopped close to her head, and raised itself in order to reach her mouth. Immediately a tiny drop of clear fluid shining like a diamond appeared in its jaws, to disappear at once into the mouth of the queen. As soon as he had tendered his morsel to his sovereign, the worker walked round her gigantic body, so as to reach the exit on the opposite side from that by which he had entered. The work, therefore, went with the greatest speed and regularity, without any worker ever impeding another unnecessarily.

2. With these workers and in the same streams were some who had the task of carrying away the eggs and caring for them. These workers, too, walked right round the queen, to appear later carrying eggs in the outgoing stream. Mr Foster calculated that the queen laid fifty thousand eggs in twenty-four hours, which gives some idea of the speed with which the task of conveying them had to be accomplished.

3. A much smaller group of workers were occupied with a far more mysterious task. I could not find out exactly what they were doing but assumed they were busy cleaning the skin of the queen in some way. They were constantly engrossed, either singly or in groups, in some task on the queen's gigantic body. They appeared to be stroking her skin softly with their jaws in a continuous movement. We did discover that when they entered the cell their bodies were empty, whereas when they left they were filled with a colourless fluid. This fluid must therefore have been obtained in some way through the skin of the queen without in any way damaging it. We called these workers masseurs. It may be that they were appointed to some special work of feeding the young ones and that the queen secreted in her enormous body the fluid used for this purpose. I base this assumption on

what we actually saw happening when we followed up some of these masseurs after they had left the queen's cell. This observation, however, I still had some doubt about, for we experienced some difficulty in following up these workers. It appeared, however, that the masseurs after they left the cell visited one of the big breeding gardens, where there were a large number of the small white babies. Here they fed the babies with drops of colourless fluid, in exactly the same way that other workers of this class fed the queen. It occurred to me therefore that the body of the queen served as an organ for digesting food a stage further for use of part of the community. In her body a change occurs which renders the nutriment fit for infant feeding. If this is actually the case, it is the first appearance in nature of 'milk' secretion by the mother. Besides these three classes of workers and their never-ending activity, we observed an even more interesting phenomenon in the palace cavity. The cell of the queen was encircled by a ring of the bigger soldiers. These soldiers were equidistant from each other. The plane of the circle was placed at an angle of approximately 45 degrees to water-level. In the foreground of the palace cavity the soldiers were standing on the floor, while at the opposite side they were hanging upside down from the roof. All their heads were turned directly to the magnetic north. I think this fact is of importance, because I am convinced that the magnetism of the earth has a noticeable effect on most kinds of termite, as has already been indicated in connection with the water-shaft in Africa and in the shape of the termitaries of the magnetic ant of Australia. The members of this bodyguard, as we may call it, were, for most of the time, entirely motionless. Every now and then, however, one of them became activated with a curious motion, a swaying to and fro of the head and foremost part of the body, which reminded me of the well-known termite dance described by observers. As soon as one member began

these movements he infected within a few seconds the soldier nearest him on his right side, who in his turn handed it on to the one next to him and so on from one to another, until the peculiar dance had been transmitted right round the circle, to end where it had begun.

We also saw the changing of the guards. The new guards entered the palace cavity by a large opening nearly opposite the head end of the cell, and formed a second circle within the circle of the guards about to be relieved. The new guards then gradually widened their circle to take their places between the old guards. This was the signal for the latter to leave the cell in single file by the same opening. This was the only activity we observed on the part of these soldiers.

What could be the function of this mysterious circle? Another observer, who later had the opportunity of seeing them in German West Africa, describes them with the utmost assurance as real bodyguards which fulfil the same function as royal bodyguards do in the case of a human sovereign. I am afraid I cannot accept this theory. Any enemy which had succeeded in penetrating the nest thus far, would surely be capable of overcoming this single line very easily. One must remember that such an enemy would have come through miles of passages where he would meet countless soldiers of the same class, who would, *à outrance*, withstand every inch of his approach with every means of attack and defence. If he had succeeded in forcing his way thus far, no mere circle of bodyguards would be the slightest use. I may add that I never succeeded in stirring up this bodyguard to attack. I could touch them with my finger and move them from side to side, without any of them making the least attempt to bite, which any other soldier of the same class would have done immediately in any other part of the nest. They appeared to me to be semi-conscious like chloroformed termites.

I immediately formulated another theory. The termitary is such a perfect analogy to the physical body of an animal with its brain, its stomach and liver, its blood-stream consisting of two kinds of corpuscles, that I am inclined to clarify any unknown phenomenon in the termite by comparison with higher animals. It had always appeared to me that there was one analogous organ lacking in the termitary. I had always felt that there should be some system with a similar function linking up the community and its 'brain', the queen, as is found in the central nervous system of animals. I had always been searching for something which would be the functional equivalent of the *medulla oblongata* and the vertebral column; which would act as a link to carry the mysterious influence of the queen to all parts of the community. I must admit that this is a theory which is supported by very few observations. I am giving it here for what it may be worth. Perhaps future observers will have the opportunity of investigating this mysterious circle more thoroughly and establishing its functions. Of one thing we may be certain, that such a complicated and regular phenomenon must have some definite purpose.

I must describe another occurrence which took place during our observation because it bears upon the theory of the organic unity of the termitary.

While we were watching the queen, a fairly large piece of hard clay became detached from the edge of the roof of the cell and fell down, dealing the queen a somewhat hard blow. Immediately a series of extraordinary occurrences took place. The only effect which the shock had on the queen herself, was that she began moving her head to and fro in a rhythmic fashion. The workers immediately ceased all work within the cell and wandered round in aimless groups. The circle of bodyguards broke up at once and most of them vanished down the passages behind the palace cavity. Then we saw masses of

tiny workers thronging into the palace cavity and cell. They swarmed over the queen in order to suck the fluid through her skin, in exactly the same way as the masseurs had done in normal circumstances. The king greedily took part in this draining of his mate. They succeeded so well that within a few minutes the skin of the queen was hanging in loose folds.

In the meantime we visited far outlying parts of the nest, where the termites had been very active just before the accident. Even in the farthest parts all work had ceased. The large soldiers and workers gathered in great excitement in different parts of the nest. There appeared to be a tendency to collect in groups. There was not the least doubt the shock to the queen was felt in the outermost parts of the termitary within a few minutes. Recovery began in the same place where the first and greatest disturbance took place. Slowly the destructive workers stopped their assault on the queen. The bodyguards took up their positions in a circle and the queen ceased the rhythmic movements of her head. She appeared to be recovering from the shock. So quickly that it was barely possible for me to follow all the stages, normal activity began anew. The only difference in conduct which I could notice was that the workers appeared to be speeding up the feeding of the queen, and before long her body had resumed its usual gigantic size. The following day all activity in the outermost parts of the termitary was in full swing.

And that was the end of our observations.

The workmen had occupied themselves with excavating and removing the breeding gardens in other rooms, but now the time allotted to us had come to an end. The queen was removed from her half-cell and taken away captive; and after that the activities and life of this nest ceased for good.

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